HYDRO-ELECTRIC POWER COMMISSION
OF ONTARIO

RULES
AND
REGULATIONS
FOR
Inside Electrical Installations

Including also Rules on

Signalling Systems, Wireless Telegraph Apparatus, Electric Railway Work, Etc.

FOURTH EDITION
July 1st, 1916

PRINTED BY ORDER OF
THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO:
Printed and Published by A. T. WILGRESS, Printer to the King's Most Excellent Majesty
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PREFACE

Object of Rules

The object of the Rules and Regulations is to provide a standard for electrical installation and material, the proper observance of which will eliminate, so far as is practicable and reasonable, risk of injury to persons and property, and also of fire.

Scope of Rules

These Rules and Regulations have reference only to inside work in ordinary buildings, e.g., residences, warehouses, factories, etc., and such work as may be attached to the outside of such buildings, and to the wiring of electric railway cars and car houses. Wiring and apparatus for signalling systems are also dealt with, but only on account of possible damage from power or lighting systems.

Central and sub-station work for public supply, overhead and underground transmission and distribution, electrical work in mines, marine work and all electrical work involving potentials exceeding 5,000 volts are not taken into consideration herein.

General Arrangement of Rules

The Rules in Section "A" cover chiefly such generating, transforming or other plant as is intended only for private supply to or by an individual or a Company and not that in central or sub-stations such as are usually designed by competent engineers. To all such work of the latter nature the Rules herein contained will apply in so far as they may be applicable, but in any case each separate generating or other plant will be treated on its own merits. The plants referred to in Section "A" may, however, be used to a limited extent for public supply, and the Commission may grant approval

EXECUTIVE COUNCIL OFFICE.

TORONTO, 15th June, 1916.

W. W. POPE, ESQ.,
Secy. Hydro-Electric Power Commission,
Toronto.

DEAR SIR:—

I beg to enclose for your information copy of an Order of His Honour the Lieutenant-Governor in Council approving of Regulations made by the Hydro-Electric Power Commision, in connection with generation of electric power, etc.

Yours truly,

(Sgd.) J. LONSDALE CAPRÉOL.

EXECUTIVE COUNCIL OFFICE.

Copy of an Order-in-Council approved by His Honour the Lieutenant-Governor, the 15th day of June, A.D., 1916.

Upon the recommendation of the Honourable the Attorney-General, the Committee of Council advise that pursuant to the provisions of Section 10 of the Power Commission Act, 1916, Cap. 19, 6 George V., Your Honour may be pleased to approve of the accompanying Regulations made by The Hydro-Electric Power Commission of Ontario as to the design, construction, installation, protection, operation, maintenance and inspection of works, plant machinery, apparatus, appliances, devices, material and equipment for the generation, transmission, distribution, connection and use of electrical power or energy by any municipal corporation or Commission, and by any railway, street railway, electric light power or transmission company, or individual, generating, transmitting, distributing or using electric power or energy, or whose undertaking, works or premises are electrically connected with any plant for the generation, transmission or distribution of electric power or energy.

Certified,

(Sgd.) J. LONSDALE CAPRÉOL.

Clerk, Executive Council.

An Act to amend the Power Commission Act, 6 George V., Chapter 19, Section 37, 1916.

5 Geo. V, c. 19, s. 12, amended.

Section 37 of *The Power Commission Act*, as enacted by section 12 of *The Power Commission Act, 1915*, is repealed and the following substituted therefor:—

Regulations as to electrical works.

37.—(1) The Commission may, with the approval of the Lieutenant-Governor in Council, make regulations as to the design, construction, installation, protection, operation, maintenance and inspection of works, plant, machinery, apparatus, appliances, devices, material and equipment for the generation, transmission, distribution, connection and use of electrical power or energy by any municipal corporation or commission and by any railway, street railway, electric light, power or transmission company, or by any other company or individual generating, transmitting, distributing or using electric power or energy, or whose undertaking works or premises are electrically connected with any plant for the generation, transmission or distribution of electric power or energy, and the Commission may impose penalties for the breach of any such regulations.

Order of Commission as to work to be done.

(2) The Commission may, at any time, order such work to be done in the installation, removal, alteration or protection of any of the works mentioned in subsection 1, as the Commission may deem necessary for the safety of the public, or of workmen, or for the protection of the property damaged by fire or otherwise, and pending the performance of such work, or in case of noncompliance with the regulations or with any order of the Commission, may order the supply of electrical power or energy to be cut off from such works.

Ordering cutting off of supply.

Inspectors and their duties.

(3) The Commission may appoint inspectors for the purpose of seeing that the regulations and orders of the Commission, made under the authority of this section, or any other provision

of this Act, are carried out and may collect the fees to be paid by any municipal corporation or commission, or by any company, firm, or individual under the regulations or by order of the Commission, and may provide for the payment of the remuneration, travelling and other expenses of the Inspector out of the fines and fees so collected or out of the funds appropriated for carrying on the work of the Commission.

Powers as to entering on property.

(4) Every Inspector so appointed may, during any reasonable hour, enter upon, pass over or through any land, buildings or premises for the purpose of carrying out the regulations and orders of the Commission, and perform the duties assigned to him; and every municipal corporation, or commission, company, firm, or individual, molesting, hindering, disturbing or interfering with an inspector in the performance of his duty, shall be guilty of an offence, and shall incur the penalty provided by subsection 7.

Duty as to complying with written order of Commission.

(5) Every municipal corporation or commission, and every company, firm, or individual, upon receiving notice in writing by the Commission to remedy any defect or to make any alteration, or carry out any work, or comply with such notice within the time thereby prescribed, and in default, shall incur the penalty provided by sub-section 7.

Penalty for supplying electricity before works approved.

(6) Every municipal corporation or commission, and every company, firm or individual, supplying electrical power or energy for use in any electric works, plant, machinery, apparatus, appliance or equipment before the same have been inspected and such supply authorized by the certificate of the Commission, and after notice from the Commission of the unauthorized supply or use, shall incur a penalty of not less than $300 nor more than $500.

Penalty for disobeying order to discontinue supply.

(7) Every municipal corporation or commission, and every company, firm and individual, refusing or neglecting to disconnect or discontinue the supply of electricity to any electric works, plant, machinery, apparatus, appliances, or equip-

ment, upon due notice in writing from the Commission so to do, shall incur a penalty of not less than $300 nor more than $500.

Other liability not affected.

(8) Nothing in this Act shall affect the liability of any municipal corporation or commission, or of any company, firm, or individual, for damages caused to any person or property by reason of any defect in any electric works, plant, machinery, apparatus, appliance, device, material, or equipment, or in the installation or protection thereof, nor shall the Commission or any inspector incur any liability by reason of any inspection or the issue of any certificate or on account of any loss occasioned by the cutting off of the supply of electrical power or energy in accordance with the orders of the Commission.

Penalty for disobeying regulations.

(9) Every municipal corporation or commission, and every company, firm or individual, disobeying the provisions of this Act, or of the regulations, or any order of the Commission, shall incur a penalty of not less than $10 nor more than $50, and in the event of continuing the offence, of not less than $10 nor more than $50 for every day during which such offence continues.

Recovery of penalties under Rev. Stat., c. 90.

(10) The penalties imposed by or under the authority of this section shall be recoverable under *The Ontario Summary Convictions Act* and shall be paid over to the Commission.

for the use of such plants for public supply on being satisfied that any alterations or additions which may be found necessary have been properly carried out.

Section "B" consists of Rules for apparatus, fittings, etc., and wiring under "ordinary conditions," followed by rules necessary for work under "special conditions."

The rules dealing with special conditions are intended to apply only to such installations or portions thereof, as may require their observance, e.g., it is evident that in damp premises any equipment, etc., which may be installed in some room or portion of such premises from which dampness is excluded, will not be required to come under the special rules for damp places.

The rules under Section "C" deal with varieties of work which, as they differ in some essentials from ordinary installation work, cannot be governed by exactly the same regulations.

The remainder of the book consists of sundry necessary items which do not properly come under the head of installation work.

General Precautions

Where persons entirely without knowledge of electrical apparatus are obliged to operate switches, etc., in offices, houses, hotels, and the like, the whole of the work must be carried out in such a manner as to reduce the risk of accidental shock to the lowest possible degree. It is to this end that all live parts in such premises must be so placed or protected that no one would be likely to accidentally receive a shock or be burned.

In installations or portions thereof to which only authorized persons have access, somewhat less care is necessary in obviating risk of shock with potentials below 650 volts. The term "Inaccessible to unauthorized persons" will be sufficiently complied with under the rules for low potentials if the apparatus, etc., referred to be placed in a room to which the entrance of unauthorized persons is forbidden, or a railing may be placed around a motor or switchboard, etc., with a suitable notice nearby forbidding unauthorized per-

sons to go within the railing, whereas, when the potential exceeds 650 volts, special precautions are necessary to render it unlikely that even authorized persons will accidentally receive shocks, i.e., live parts must be covered, guarded or placed out of reach, and exposed metal parts which do not carry current must be grounded.

By "exposed metal parts which do not carry current" is meant only such bare metal parts as would be likely to become live either through the breakdown of any insulation between them and the live parts, or by reason of any foreign body, such as a nut, falling and accidentally connecting the case to the live parts. The term does not refer to covers of switches, sockets, receptacles, etc., which are specially lined, nor to the ferrules on knife switch handles, nameplates or other bare metal which is obviously not likely to ever become "live."

General Rules.

a. All electrical installation work covered by these Rules and Regulations must be carried out in accordance therewith and all electrical contractors, wiremen and others engaged on such work, within the Province of Ontario, are required to see that they conform to the rules.

b. In the interpretation of these rules all arbitrary figures or requirements must, where there can be no practicable objection, be rigidly adhered to. In any case where it is quite impossible or manifestly unnecessary to thus rigidly adhere to the rules the question must be settled by the spirit of the rule, and the Commission may allow such deviation from the rules as circumstances may permit.

In case any dispute arises as to the exact meaning or scope of any of these Rules and Regulations such dispute shall be referred to the Commission whose decision shall be final.

c. All materials, fittings, etc., used in electrical installations within the Province of Ontario must be approved by

the Commission; otherwise their use will not be permitted. Work badly arranged or poorly executed will not be passed, even if the materials, etc., used, be satisfactory.

Electrical equipment, apparatus, devices and wiring generally must be so located or protected that damage will not be likely to result either to persons or property, or to the equipment, etc.

d. Owners of factories and workshops and of any premises where employees are engaged in operating any electrical plant or apparatus, such as generators or motors, welding machines, electric smoothing irons, etc., etc., will be required to keep their entire electrical installations in good condition in accordance with Section F. herein, which deals with maintenance and operation.

e. Electrical contractors, wiremen or other persons about to carry out any installation work must notify the Commission. The notice must be in writing on the form provided for the purpose by the Commission and must be accompanied by the amount of the permit fee in accordance with the "Schedule of Fees" published herein.

f. Neither new electrical installations, nor alterations or additions to existing ones shall be undertaken by any electrical contractor, wireman, or by any other person, until a permit authorizing the work has been obtained in writing.

g. On any installation where workmen of other trades (such as carpenters, lathers, etc.) are, or will be, engaged, electrical contractors, wiremen or other persons carrying out electrical work shall place in conspicuous positions around their work, plain, legible notices warning such carpenters, etc., not to cover up or close in any electrical work from view until it has first been inspected. The posting up of one of the Commission's properly authorized and signed "Forms of Inspection" shall be evidence that this has been done.

h. Electrical contractors, wiremen, or other persons desiring to have an installation, or portion thereof, inspected, shall give not less than twenty-four hours notice, in writing, to the Commission's Electrical Inspection Department, or to the local representative thereof.

Each application for inspection shall be accompanied by the amount of the inspection fee as determined in accordance with the "Schedule of Fees" published herein.

The following schedule of fees is hereby approved and authorized by the Commission for the services designated:—

Schedule of Fees

A. For inspecting Incandescent Electric Light Wiring.

1 to 5 outlets	$0.50
6 to 10 outlets	.10
	(each additional)
11 to 50 outlets	.05
	(each additional)
51 to 100 outlets	.02
	(each additional)
and over 100 outlets	.01
	(each additional)

B. For Inspecting Motors.

Electric motors, each	$1.00
Each additional motor in same plant	.25

C. For Inspecting Electric Signs.

Electric signs, each	$1.00
More than one sign on same building	.50
	(each additional)

D. For Inspecting Electric Fixtures in Mercantile and Factory Buildings.

For certificate covering complete fixture installation along with wiring, and for same contractor, a charge of $1.00 over and above the wiring inspection fee will be made.

E. For Inspecting Residential Fixtures.

When fixtures can be inspected along with wiring, a charge of 25c. over and above wiring inspection fees will be made. When special fixture inspections are required or necessary a charge of one-half the wiring inspection fee will be made, rating each fixture as an outlet with the minimum fee of 25c.

F. For Special Inspections.

Where no special fee is provided, inspections may be made at the rate of 50c. per hour, plus any actual travelling and hotel expenses.

G. Permit Fees.

A fee of 10c. is to be paid by the applicant for each and every permit.

SECTION A

ELECTRIC PLANT

(All Potentials from 10 to 5,000 Volts)

I. GENERATORS

a. Must be located in a clean, dry place, and be either remote from combustible materials or efficiently isolated therefrom.

In order to minimize, as far as possible, the danger of shock or fire, it is necessary, in all instances, to provide a suitable location. They should never be placed where any hazardous process is being carried on, nor in places where they would be exposed to inflammable gases or flyings of combustible material.

Should it be necessary to place a generator in the work-room of a plant where combustible material abounds, as in Textile Mills, Flour Mills and such like places, it must be cut off from the main room by means of a dust-tight enclosure.

It is suggested that waterproof covers be provided, which may be used in cases of emergency.

b. Must, when operating at a potential in excess of 300 volts, have their base-frames permanently and effectually grounded. For potentials below 300 volts, the frames must be either properly grounded or efficiently insulated.

Where, on any generator operating at more than 150 volts, there are any *exposed* live parts which can be readily touched, such as brush gear, terminals, etc., an inspector may require that there be a suitable insulating platform, of such dimensions that no person could readily reach such live parts without standing on the platform.

c. Constant potential direct-current generators, except the exciters of alternating current machines, must, and alternating current generators may, be protected from excessive current by safety fuses or equivalent devices.

For two-wire direct-current generators, single pole protection will be considered as satisfying the above rule, provided that the safety device is so located and connected that the means for opening it is actuated by the entire generator current, and that the action thereof will completely open the generator circuit.

If a generator, not electrically driven, in a two-wire system, have one terminal grounded, the safety device above mentioned must be placed in the grounded lead.

If a balancer set be used in conjunction with a two-wire direct-current generator for the purpose of obtaining a neutral for a three-wire system, a protective device must be installed such that, should the voltages on the two sides of the system become excessively unbalanced, it will so operate as to disconnect the three-wire system.

d. Must be provided with a name-plate, giving the maker's name, the normal rating in volts and amperes, and the normal speed in revolutions per minute and, if alternating current, the frequency in cycles per second, and the number of phases.

e. Terminal blocks, when used on generators, must be made of incombustible, non-absorptive material, such as slate, marble or porcelain.

This would not prevent the use of appropriate bushings to protect the lead wires if brought through the frames of generators.

f. Conductors leading from generators to switchboards must be in plain sight or readily accessible; they must also have a suitable insulating covering and be securely and rigidly supported in such a manner that they cannot come

in contact with each other, in accordance with one or other of the methods of wiring described in Section "B."

Inasmuch as it is not usual to provide circuit breakers or other forms of protective devices between generators and switchboards, it is necessary that the foregoing Regulation be observed.

The conductors may, of course, be run underground in watertight conduit or tile duct, but unless such ducts can be kept dry the conductors must be lead covered.

II. STORAGE BATTERIES

a. Each storage battery cell must be mounted on incombustible, non-absorptive insulators, such as glass or thoroughly vitrified and glazed porcelain.

b. Battery rooms must be thoroughly ventilated.

c. The use of any metal liable to corrosion must be avoided in cell connections of secondary batteries.

Where the insulation on wires in battery rooms would rapidly deteriorate owing to the action of acid fumes, bare conductors may be used. For protection against corrosion a suitable acid-proof coating should be applied to such conductors.

d. Batteries must in all cases be provided with proper controlling and protecting apparatus.

The same precautions must be adopted in connection with battery installations as are necessary with current from any other source of supply, especially as a battery, unlike a generator, is never at any time "dead."

III. SWITCHBOARDS

a. Panels of switchboards must be made of incombustible, non-absorptive, insulating material.

b. Frame-work used for the support of switchboards must be substantially constructed of iron or steel.

c. Must be so placed or of such construction and general arrangements as to reduce to a minimum the danger of fire, and shock, burn or other personal injury.

Switchboards must not be built down to the floor, nor up to the ceiling; a space of at least ten inches must be left between the floor and the board, and three feet, if possible, between the ceiling and the board. This is in order to prevent fire from communicating from the switchboard to the floor or ceiling, and also to prevent the forming of a partially concealed space, very liable to be used for storage of rubbish or oily waste.

Deviations from this rule may be permitted where the floor and ceiling are fireproof.

This rule will require that switchboards be installed only in dry places.

d. Ample space must be left around every switchboard.

Serious accidents are very liable to occur if men be compelled to work on live electrical apparatus, etc., in confined situations; hence the necessity for providing ample space.

Switchboards must be easily accessible from all sides if the connections be on the back (see Fig. 1), but may, for small sizes, be mounted on a wall if the wiring be entirely on the face, provided that there is a space of at least one inch between the back of the board and the wall. Should there be, however, any live metal projections on the back of the board, such as switch terminals or other connections, this measurement must be taken from the nearest live part.

The object of this space is to prevent possible contact between the wall and live parts, as this would be liable to cause leakage, and to prevent accumulation of moisture between the back of the board and the wall. This space must be enclosed with sheet metal or other suitable incombustible material in order to prevent objects of any kind

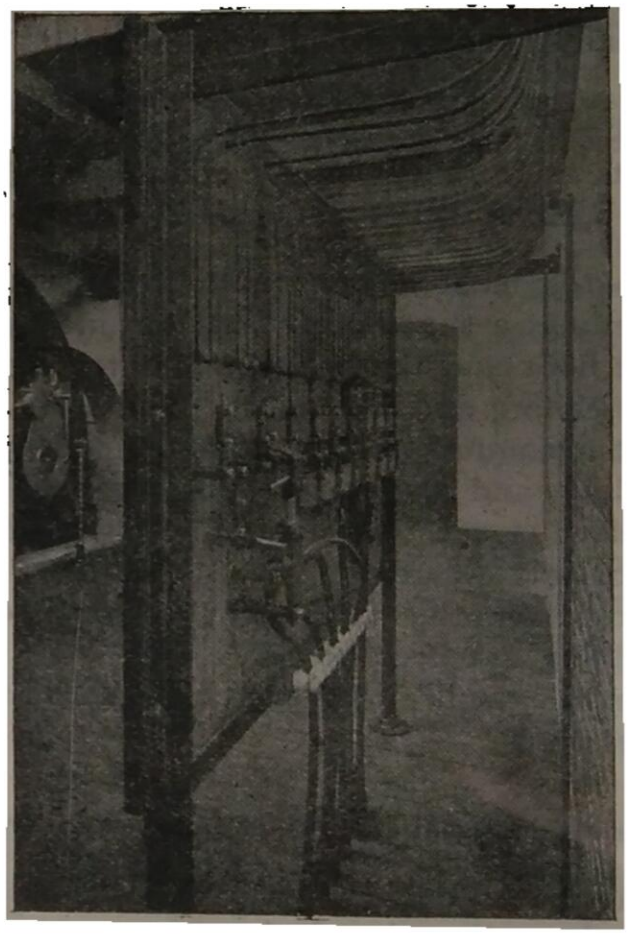

Fig. 1

from dropping or lodging behind and becoming a source of danger.

The space behind other switchboards must not be enclosed, either at the top, sides or bottom, except with a suitable metal grating or netting.

For all potentials above 650 volts, an enclosure as indicated above *must* be provided.

e. All cables, connections, resistances, etc., must be so situated as not to form any obstruction to the passageways around switchboards.

f. Where it is necessary to place bare bus-bars or any apparatus having exposed live parts, either on the wall or overhead, behind switchboards, they must be in no case less than seven feet from the floor.

This does not refer to bus-bars, etc., directly attached to the back of a switchboard.

g. Where the potential does not exceed 650 volts, and the switchboard is of such dimensions as to require a man to go behind it for the purpose of repairs or attention, there must be a clear space of not less than 18 inches between the wall and any live parts on the back of the switchboard.

By "clear space" is meant that the distance of 18 inches will be between the wall and the parts mentioned or any projecting pipe, apparatus, or other obstruction which may be attached to, or form part of, the wall.

For potentials between 650 and 5,000 volts, this space must be at least 2 feet 6 inches, unless in any particular case it can be demonstrated to the satisfaction of the Inspector that a slight reduction will not materially increase the danger to anyone who might have to carry out repairs, or alterations, behind the board.

h. For potentials from 150 to 650 volts all switchboards must either have an efficient insulating platform surrounding them, or all live parts of apparatus must either be remote from access or provided with suitable covers.

The platform called for in this rule must completely surround the switchboard, and the insulation thereby provided must be ample to afford sufficient protection against shocks. Platforms must be of rigid construction and have an even surface.

i. For potentials above 650 volts, all live parts of switchboards must be either remote from access or protected by suitable covers, even if an insulating platform be provided.

For higher potentials than 650 volts, insulating platforms are not sufficient protection against shock and further precautions must be taken as, for example, protection by a glass plate over instruments, grounded metal or insulating covers over switches, etc.

j. For potentials above 300 volts, all exposed metal parts which do not carry current, including framework, switch handles, instrument cases, etc., must be permanently and effectually grounded if there be no insulating platform. For potentials above 650 volts, such parts must be grounded even if there be an insulating platform.

This rule is of almost universal application, but there are certain cases where its enforcement would be detrimental or even defeat the object for which it is made, e.g., in electric railway work, if one pole only be brought to the switchboard, to ground the metal work on such a board would be to reintroduce a risk which had purposely been obviated by the elimination, from such board, of the other pole. It is obvious that in such a case no advantage could be gained from the application of the rule.

k. All connections must be made with as little complication as possible.

Neatness and careful arrangement in this work is very essential, and is conducive to safety. In many cases, particularly on large switchboards, it is desirable that the connections should be made more readily traceable by means of different colors or suitable tags.

l. All main circuits except such as are permanently grounded must be provided with reliable ground detectors.

Detectors which indicate continuously and give an instant and permanent indication of a ground are preferable. Ground wires from detectors must not be attached to gas pipes within a building.

Where continuously indicating detectors are not adopted the circuits should be tested at least once per day, and preferably oftener.

In wiring switchboards the ground detector, voltmeter, pilot lights and potential transformers, must be connected to a circuit of not less than No. 14 B. and S. gauge wire, which must be protected by fuses which will limit the power in the circuit to 660 watts.

In each case the fuses referred to in these circuits must be the smallest which circumstances will permit.

m. All feeder switches must be provided with proper labels which plainly indicate the destination or purpose of each circuit controlled thereby.

Card holders, with plainly written cards, will comply with this rule.

n. All current-carrying parts of switchboards, and their connections, must be so proportioned, constructed and arranged that no undue rise of temperature can occur.

This has special reference to bus-bars and other bare conductors used on switchboards, and indicates that they must be of sufficient size, and that good connections must be made; for instance, where two separate lengths of bus-bars are joined together, the contact area must be ample and the bars must be securely bolted or clamped together.

Thirty degrees centigrade (86 deg. Fahr.) above the surrounding atmosphere will be considered a satisfactory limiting rise of temperature for this class of work.

IV. LIGHTNING ARRESTERS

a. Must be attached to each wire of every outside overhead line connected with any generating or transforming station.

This rule does not apply to lines known as "yard wires," nor to ordinary overhead street service wires.

b. Must be located in readily accessible places away from combustible materials, and as near as practicable to the point where the wires enter the building.

In all cases kinks, coils and sharp bends in the wires, between the arresters and the outdoor lines, must be avoided as far as possible.

c. Must be connected with a thoroughly good and permanent ground connection by metallic strips or wires.

Such strips or wires must have a current-carrying capacity not less than that of No. 6 B. and S. gauge copper wire, and must be run as nearly in a straight line as possible from the arresters to the ground connection.

Ground wires for lightning arresters must not be attached to gas pipes within buildings, nor be run inside of iron pipes, unless they are soldered or otherwise effectively connected thereto.

d. All choke coils or other attachments inherent to lightning protection equipment, must have an insulation from the ground and from other conductors equal at least to the insulation demanded at other points of the circuit in the station.

V. TRANSFORMERS

a. Where installed inside of, or attached to, any building and where the potential on the high tension side exceeds 300 volts, the cases of both air and oil-cooled transformers must be permanently and effectually grounded. For lower potentials they must either be properly grounded or effectually insulated.

In the case of transformers (such as instrument transformers) employed as an integral, but subsidiary, part of some electrical apparatus, exposed metal parts which do not carry current must be grounded unless the transformers be so placed or guarded as to comply with the rules applicable to the higher voltage.

b. Must be located as near as possible to the point at which the primary wires enter the building.

This rule assumes that most transformers will be used for stepping down, as is usually the case; should, however, a transformer be used for stepping up it will be desirable to so locate it that the high voltage leads shall be as short as possible. Where the highest voltage does not exceed 650 the rule as it stands should be observed in any case.

OIL-COOLED

c. Must be placed in fireproof compartments and must be entirely remote from all combustible material.

The risk of fire, should the oil become ignited, is very great, as it would be very difficult to extinguish it.

Fireproof compartments must be so made that oil could not leak out and, in the case of large transformers, such compartments must have a suitable outlet, near the top, to the open air, to allow of the escape of gases and prevent possible explosion.

Inlet for fresh air is to be provided by a flue or iron pipe leading from the outside air and entering the vault at a point not less than three feet from the floor. In no case must the inlet be less in area than the equivalent of a six-inch pipe.

Where practicable, such compartments must only be accessible from the outsides of buildings, and must have a sill on the floor, at the door opening, of such a height as to

effectually prevent oil from overflowing through the doorway.

The floor should drain to one point, and may be connected to the drainage system or to an underground tank located outside the building.

An approved fire-door must be provided and equipped with a lock.

d. Must not be located over roofs of any buildings, nor directly attached to the walls of frame buildings, but may be attached to brick, stone or concrete walls or to metal walls not built on wooden framing.

Where no other location is practicable, they may, however, be supported on the walls of frame buildings on metal brackets, which will separate the transformers at least two feet from the nearest woodwork.

Care must be exercised, when locating transformers on walls, not to place them immediately under the eaves or woodwork of cornices, nor in the immediate vicinity of window or other openings.

AIR-COOLED

e. Must not be placed inside of any building excepting stations, if the highest available voltage of either the high or low tension winding exceeds 650 volts.

Special permission may be given for the use of small air-cooled transformers (up to 1 k.w.) for testing purposes.

f. Must be so mounted that the case will be at a distance of at least one foot from combustible material or separated therefrom by incombustible, non-absorptive insulating material, such as slate, marble or soapstone.

This will require the use of a slab or panel somewhat larger than the transformer.

As it frequently happens that transformers are properly installed in the first instance, but that, later, combustible materials are placed or stored in the vicinity, they must be suitably partitioned off with incombustible material, which must in all instances surround the transformers, where there is any likelihood of this being done. A substantial wire netting is recommended as an effective protection.

VI. MOTORS

ALL MOTORS A.C. AND D.C.

a. Motors and their equipment must be so located or protected as to reduce the risk of fire, and shock or other injury, to a minimum.

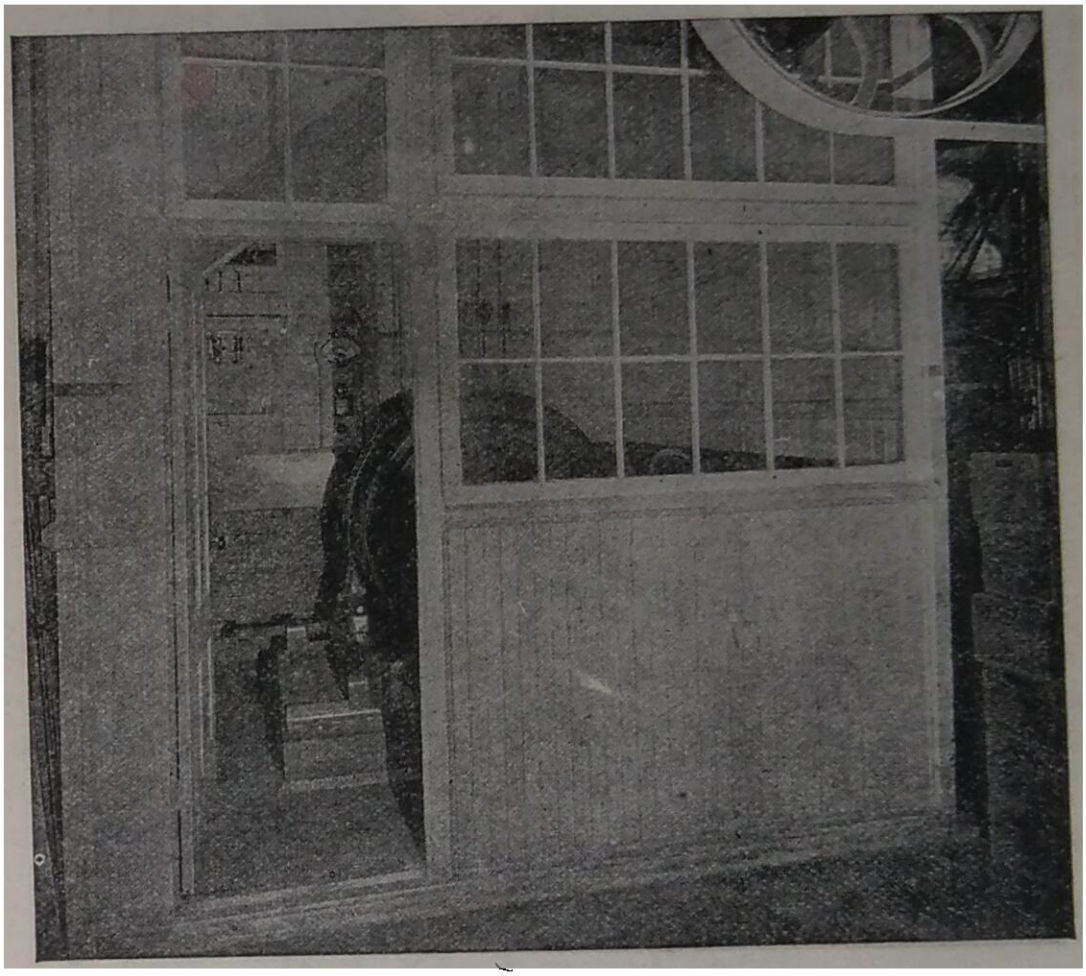

Fig. 2

This rule would require in the case of commutator motors that they be located in such a way that sparks from the commutator would not be likely to ignite inflammable material such as an oily floor, or dust or lint which might accumulate thereon. Commutator motors should never be placed directly on a wooden floor, but should be provided with a suitable galvanized iron tray, or the floors should at least

be covered with a sheet of galvanized iron sufficiently large to effectively prevent the communication of fire to the floor from the causes referred to above. Care must also be exercised in the proper grounding of the frames of motors where called for. The use of terminal boards with exposed live parts will not be permitted where employees or others could inadvertently come in contact therewith, or where they

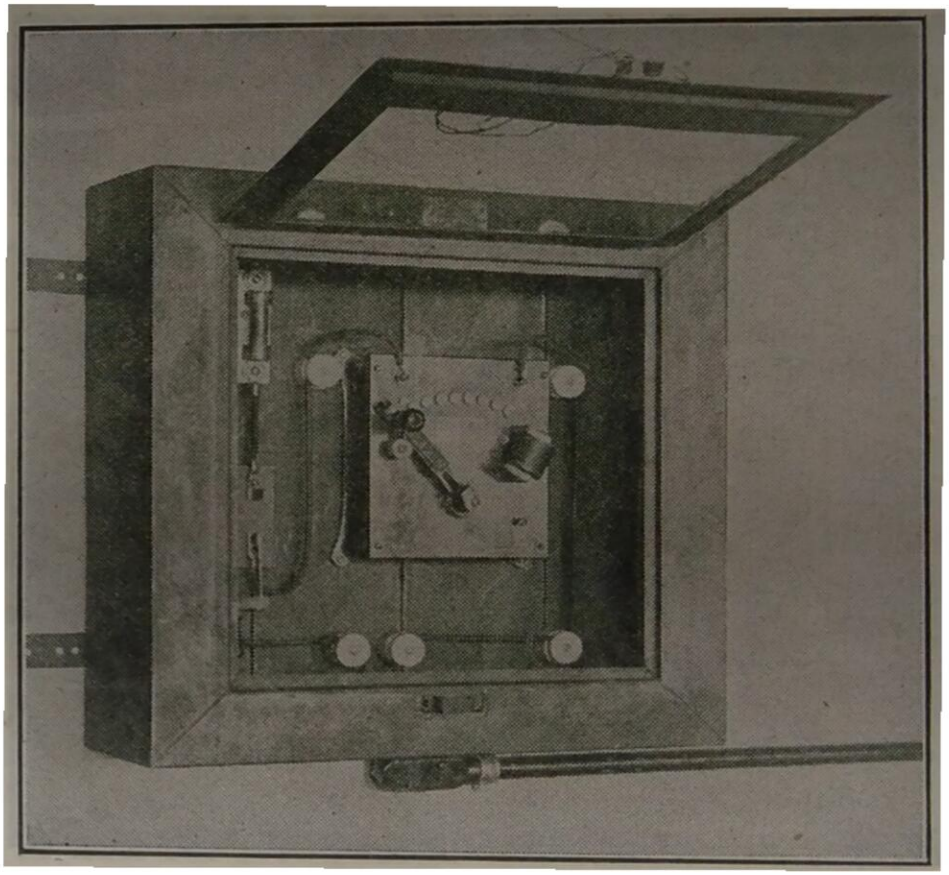

Fig. 3

would be considered a fire hazard. Either an approved form of connector, or a terminal board without open connections, must be used. Where there is danger of persons coming in contact with these or other live parts of the motor, the motor may be covered with a suitable wire cage, or located inside a metal enclosure sufficiently ventilated to prevent an excessive rise of temperature and of sufficient size to allow free access to all parts of the machine.

The same general precautions apply to starting apparatus. Open switches or starting devices must not be used if located where they can be inadvertently touched or can be handled

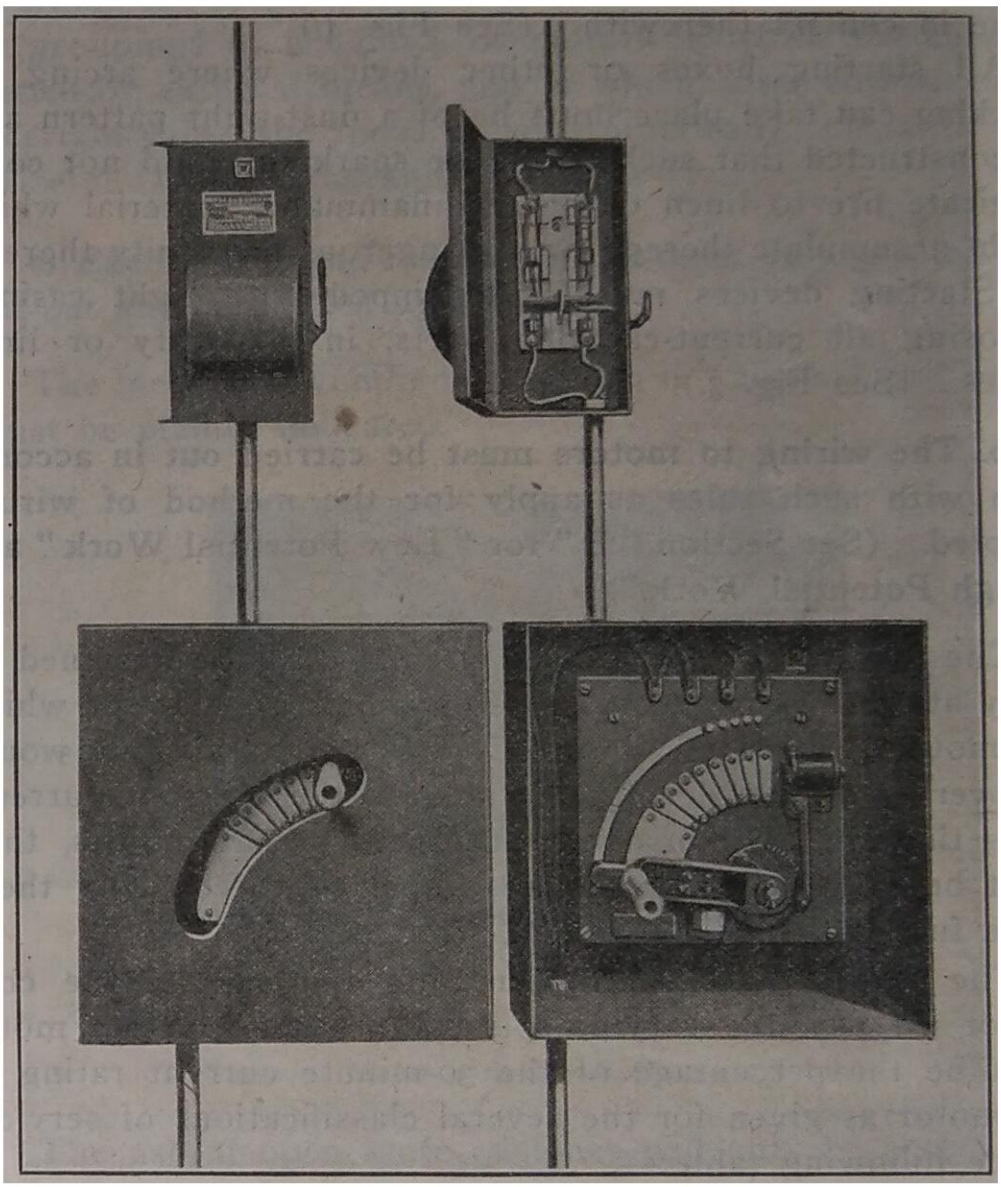

Fig. 4

Showing properly installed starting apparatus. Left hand boxes are closed as normally required in practice; right hand boxes are open for purposes of illustration.

by unskilled persons. The placing of a switch and starting apparatus in an enclosure as shown in Fig. 3 is only permitted when the operation thereof is entirely in the hands of a skilled person and where the enclosure is under lock and

key. In other cases the switch must be of an enclosed type which can be operated by a handle on the outside, and the starting box must be of the all-enclosed type, or the bare parts covered in such a way that no one can accidentally come in contact therewith. (See Fig. 4.)

All starting boxes or other devices where arcing or sparking can take place must be of a dust-tight pattern and so constructed that such arcing or sparking could not communicate fire to linen or other inflammable material which might accumulate thereon or in dangerous proximity thereto.

Starting devices must be equipped with tight casings enclosing all current-carrying parts, in all dusty or linty places. (See Fig. 3.)

b. The wiring to motors must be carried out in accordance with such rules as apply for the method of wiring adopted. (See Section "B" for "Low Potential Work" and "High Potential Work.")

The motor leads or branch circuits must be designed to carry at least 25 per cent. more current than that for which the motor is rated. Where the wires under this rule would be overfused in order to provide for the starting current, as is the case with many alternating current motors, they must be of such size as to be properly protected by these large fuses.

The current used in determining the size of the conductor for any one varying-speed alternating current motor must be the percentage of the 30-minute current rating of the motor as given for the several classifications of services in the following table:—

Classification of Service—	Percentage of current rating of Motor
Operating valves, raising or lowering rolls, tool heads, etc.	200
Rolling tables	180
Hoists, rolls, ore and coal-handling machines	150
Freight and passenger elevators, shop cranes, tool heads and pumps	120

Varying speed motors are motors in which the speed varies automatically with the load, decreasing when the load increases, and vice-versâ. The term does not mean motors in which the speed is varied by the use of different windings or groupings of windings, or motors in which the speed is varied by external means, and in which, after adjustment to a certain value, the speed remains practically constant. (See "Useful Data," paragraph "b," page 137.)

c. Each motor and resistance box must be protected by a cut-out and controlled by a switch.

The fact as to whether the switch is "closed" or "open" must be plainly indicated.

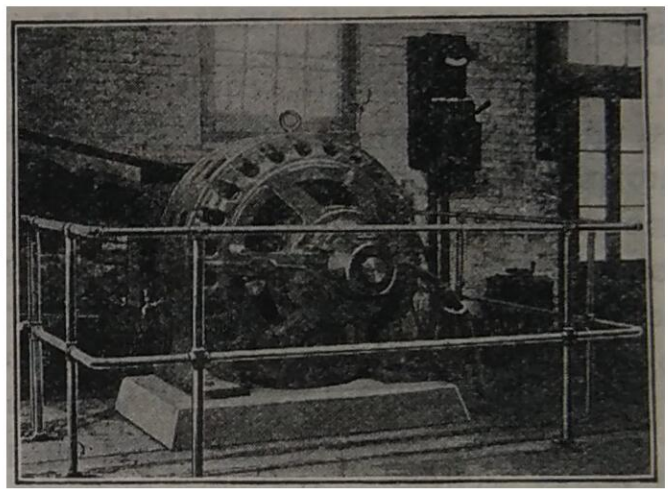

Fig. 5

Showing Motor with Pipe Railing around it.

The use of open knife switches will only be permitted if they be located where employees or unskilled persons cannot come in contact therewith.

Small motors may be grouped under the protection of a single set of fuses, provided that the current rating of the fuses does not exceed 10 amperes and the total wattage of the circuit does not exceed 660.

With motors of one-fourth horse-power or less, on circuits where the potential does not exceed 300 volts, single pole switches may be used.

The starting equipment must, where practicable, be located within sight from the motor.

Where the circuit-breaking device on the motor-starting equipment disconnects all wires of the circuit, the switch called for in this rule may be omitted.

Overload-release devices on motor-starting rheostats will be considered to take the place of the cut-out required by this rule, if they be inoperative during the starting of the motor.

An automatic circuit-breaker, disconnecting all wires of the circuit may, however, serve as both switch and cut-out. (See "Controlling and Protecting Apparatus," Rule "g," page 26.)

A.C. MOTORS

Where the starting current required for alternating current motors, up to, but not including, 5 h.p., does not exceed twice the normal full load current, they may be protected by one set of fuses; but where it is necessary to fuse the circuit beyond this limit, and in sizes from 5 to 7½ h.p. inclusive, they must be started with an approved form of double-throw switch, plainly indicating the starting and running sides, and constructed in such a way that the switch cannot be accidentally left in the starting position. The switch must be properly fused on the running side, but may be connected directly to the circuit on the starting side.

In larger sizes all alternating-current motors must be started with approved compensators or equivalent devices.

Where rubber-covered conductors carry the current of only one a. c. motor of a type requiring a large starting current, they may be protected either by fuses or by automatic circuit breakers without time limit devices, rated in accordance with Table "B," "Conductors."

The rated continuous current capacity of a time-limit circuit-breaker protecting a motor of the above type need not be greater than 125 per cent. of the motor current rating, provided that the time-limit device is capable of preventing the breaker from opening during the starting period.

d. The frames of stationary motors must be grounded in the same manner and under the same conditions as called for under Rule "b," "Generators."

e. Must not be run in series-multiple or multiple-series, except on constant potential systems, and then only by special permission.

The objection to combinations of this character is that the cutting out of one motor, by accident or carelessness, may subject the others to a current or voltage greater than that for which they are designed and, should this occur and the protecting devices fail, as sometimes happens, there is very likely to be severe arcing, or a burn-out.

f. Must, when combined with ceiling fans, be hung from insulated hooks, or else there must be an insulator interposed between the motor and its support.

g. Must each be provided with a name-plate giving the maker's name, the rating in volts and amperes, the normal speed in revolutions per minute, and if for alternating current, the frequency in cycles per second, and the number of phases.

All varying (or variable) speed motors, except those used for electric railway car service, must be marked with the maximum current which they can safely carry for thirty minutes, starting cool.

h. Terminal blocks, when used on motors, must be of approved incombustible, non-absorptive, insulating material, such as slate, marble or porcelain.

In all cases terminal blocks, if used, must be of such a type that it will be impossible to come accidentally in contact with live parts or to short circuit them.

i. Adjustable speed motors, unless of special and appropriate design, if controlled by means of field regulators, must be so arranged and connected that they cannot be started under weakened field.

VII. ELECTRIC CRANES

All wiring, apparatus, etc., not specifically covered by special rules herein given, must conform to all such rules in this book as are applicable thereto, except that the switch referred to under "Motors," Rule "c" may be omitted.

1. WIRING

a. All wires, except bare collector wires, those between resistances and contact plates of rheostats and those subjected to severe external heat, must be approved, rubber-covered, and not smaller in size than No. 12 B. and S. gauge. Wires between resistances and contact plates of rheostats, if subjected to severe external heat, must have an approved slow burning insulation.

b. All wires, excepting collector wires and those run in metal conduit or approved flexible cable, must be supported by knobs or cleats which separate them at least one inch from the surface wired over, but, in dry places, if space be limited and the requisite minimum separation cannot be obtained, each wire must be separately encased in approved flexible tubing securely fastened in place.

Collector wires must be supported on suitable insulators so mounted that even with the extreme movement permitted the wires will be separated at all times at least one and one-half inches from the surface wired over. Collector wires must be held at the ends by suitable strain insulators.

c. Main collector wires carried along the run-ways must be rigidly and securely attached to their insulating supports at least every twenty feet, and separated at least six inches when run in a horizontal plane; if not run in a horizontal plane, they must be separated at least eight inches. If spans longer than twenty feet are necessary, the distance between wires must be increased proportionately, but in no case shall the span exceed forty feet.

d. Where bridge collector wires are over eighty feet long, insulating supports on which the wires may lie loosely must be provided at least every fifty feet.

Bridge collector wires must be kept at least two and a half inches apart, but a greater spacing should be maintained wherever practicable.

e. Collector wires must not be smaller in size than specified in the following table for the various spans:—

Distance in feet between rigid supports	Size wire required B. and S. Gauge No.
0 to 30	6
31 to 60	4
over 60	2

2. COLLECTORS

Collectors must be so designed that sparking between them and collector wires will be reduced to a minimum.

3. SWITCHES AND CUT-OUTS

a. The main collector wires must be protected by a cut-out and the circuit controlled by a switch. The cut-out and switch must be so located as to be easy of access from the floor.

b. Cranes operated from cabs must have a cut-out and switch connected into the leads from the main collector wires and must be so located in the cab as to be readily accessible to the operator.

c. Where there is more than one motor on a single crane, each motor lead must be protected by a cut-out located in the cab.

4. CONTROLLERS

Controllers must be installed according to the rules under "Resistances," except that if a crane be located out of doors, wires between resistances and contact plates of rheostats must have a rubber insulation where they are exposed to moisture, and also where they are grouped.

If a crane operate over readily combustible material, the resistances must be placed in an incombustible enclosure, thoroughly ventilated and so constructed that it will not permit any flame or molten metal to escape in the event of resistances burning out. If the resistances be located in the cab this result may be obtained by constructing the cab of non-combustible material and providing sides which enclose the cab from its floor to a height of at least 6 inches above the top of the resistances.

5. GROUNDING

All exposed metal parts, which do not carry current, including handles, covers, motor frames, the entire frame of the crane, and the tracks, etc., must be permanently and effectually grounded.

6. PROTECTION OF LIVE PARTS

For potentials above 150 volts all live ungrounded parts of motors, apparatus, etc., must be so placed or guarded that they cannot be accidentally touched.

If it is impossible to place or guard the trolley wires, so as to comply with this rule, suitable warning notices must be placed in conspicuous situations.

SECTION B

INSTALLATION WORK

(All Potentials from 10 to 5,000 Volts)

I. APPARATUS, FITTINGS, FIXTURES, ETC.

For potentials up to 300 volts all live parts of apparatus and fittings must be so placed or protected that unauthorized persons will not be liable to accidentally receive shocks therefrom.

For potentials between 300 volts and 650 volts all such parts must be so placed or protected that unauthorized persons cannot come into accidental contact therewith.

For higher potentials, see "High Potential Work," Rule "d."

1. Controlling and Protecting Apparatus

(Switches and Cut outs)

a. Switches and cut-outs must be readily accessible, in plain sight, and unless specially designed for use in damp places must be located in dry situations. Where practicable they should be grouped. In all cases where they could be inadvertently touched or become a source of danger to either persons or property they must be in the form of approved panels or enclosed in approved pockets, boxes or cabinets.

Must not be placed where exposed to mechanical injury nor in the immediate vicinity of easily ignitible stuff, nor where exposed to inflammable gases or dust, or to flyings of combustible material.

Where the occupancy of a building is such that switches, cut-outs, etc., cannot be located so as not to be exposed as above, they must be enclosed in approved dust-proof cabinets, with self-closing doors; oil switches, and circuit breakers which have dust-tight casings, are excepted. (See Figs. 6 and 7.)

Key sockets will not be approved if installed over specially inflammable stuff, or where exposed to flyings of combustible material.

Remote control switches, where the means of control is accessible, will be considered as complying with the rule.

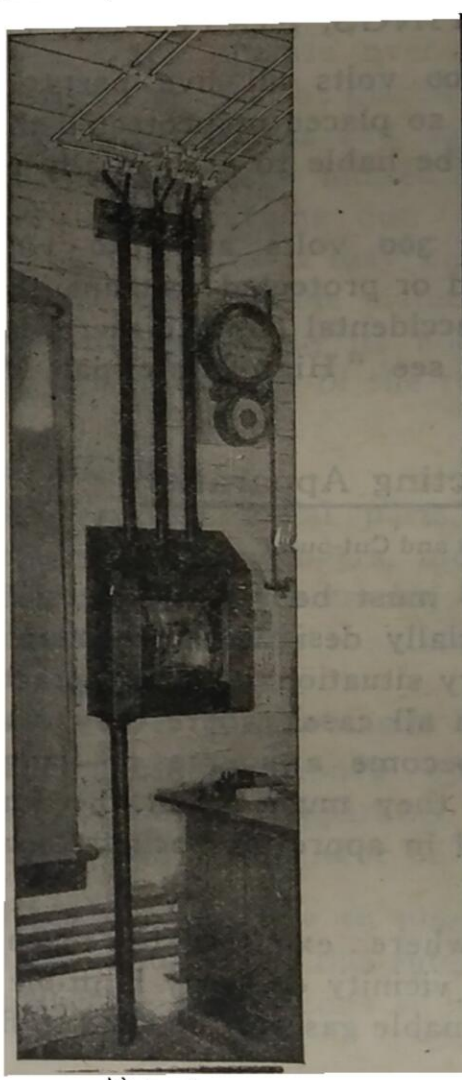

Fig. 6

Fig. 7

Single-throw knife switches must be so placed that gravity will not tend to close them. Double-throw knife switches may be mounted so that the throw will be either vertical or horizontal, as preferred, provided that, if mounted vertically, they be furnished with a suitable stop which will effectually prevent them from being closed by gravity.

When practicable, switches must be so wired that the blades will be "dead" when the switches are open.

Up to 250 volts and 30 amperes, indicating snap switches are preferable to knife switches for lighting circuits.

The use of open fuses will not be permitted.

b. Cut-outs must be placed at every point where a change is made in the size of wire (unless the cut-out in the larger wire will protect the smaller).

Fixture wire, or flexible cord of No. 18 B. and S. gauge, will be considered as properly protected by 10 ampere fuses.

c. Cut-outs must not be placed in the canopies or shells of fixtures.

d. Cut-outs must be so arranged that no set of incandescent lamps requiring more than 660 watts, whether grouped on one fixture or on several fixtures or pendants, will be dependent upon one cut-out.

In order to determine the minimum number of lighting circuits required, in residential work, all pendant outlets shall be considered as taking not less than 120 watts and bracket outlets not less than 60 watts.

Receptacles, used for portable lamps only, may be rated as brackets.

Exceptions may be made in the case of large fixtures.

The above shall also apply to motors, except that small motors may be grouped under the protection of a single set of fuses, provided that the current rating of the fuses does not exceed 10 amperes.

The fuses in the branch cut-outs, except for motors, as noted above, must not have a rating greater than that given in the following table:—

55 volts or less	12 amperes
Over 55, up to 250 volts	10 amperes

For sign and outline wiring, supplied by circuits of 55 volts or less, branch circuit fuses of 25 ampere capacity may be used.

e. In three-wire, direct-current or single-phase systems, the fuses must be omitted from the neutral wires.

Under the above conditions, all branches or taps (from any such three-wire systems), which are directly connected to lamp sockets, or other translating devices, must be run as two-wire circuits; and *every* branch or tap must be so run, if the difference of potential between the two outside wires be over 250 volts; in either case, both wires of such branch or tap circuits must be protected by proper fuses.

The neutral wire must, in all such cases, be at least equal in carrying capacity to that of the larger of the outside wires.

The neutrals of all such systems as are referred to in the rule must be grounded, as will be required by those sections of the "Rules and Regulations" not yet published.

Pending the issue of such sections, and until further notice, the grounding of such wires must be carried out in accordance with the rules in Section "E," "Grounding" herein contained.

f. The rating of fuses must not exceed the allowable current carrying capacity of the wires as given in Tables "A" and "B," "Conductors."

Circuit breakers must not be set to operate at more than 30 per cent. above the allowable current-carrying capacity of the wire unless a fusible cut-out be also installed in the circuit.

Where rubber-covered wire is used for the leads or branches of alternating current motors of the type requiring large starting currents, the wire may be protected in accordance with Table "B," "Conductors," except when circuit breakers, equipped with time-element devices are installed.

g. Each main lead of motor circuits, except on a main switchboard or when otherwise subject to competent super-

vision, must be protected by a fuse whether automatic overload circuit-breakers be installed or not.

Single-phase and direct-current motors may have one side protected by an approved automatic circuit-breaker only if the other side be protected by a fuse. For circuits having a maximum capacity greater than that for which enclosed fuses are approved the use of circuit-breakers alone will be permitted.

h. Single pole switches must not be used for the control of outdoor signs, nor placed in the neutral of a three-wire system except in a two-wire branch or tap circuit, supplying not more than 660 watts.

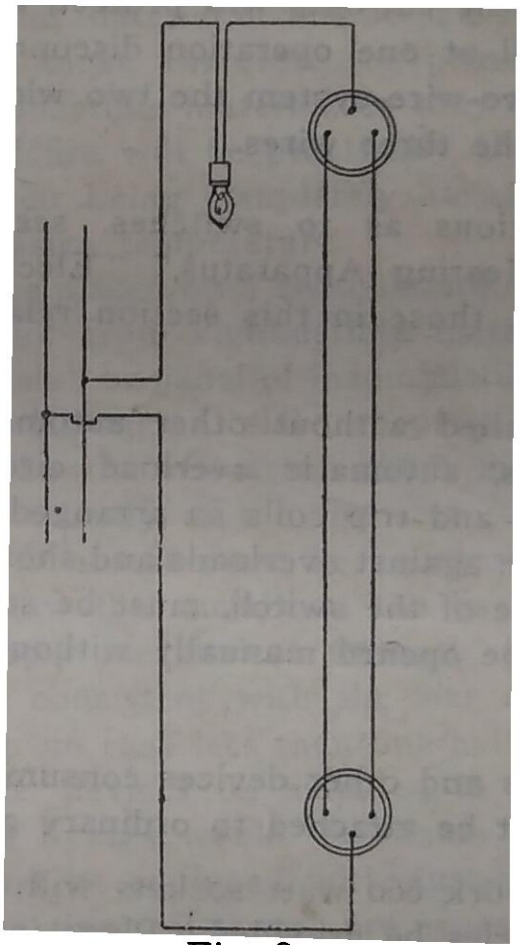

Fig. 8

When wiring for so-called three-way switches, or any similar switches controlling lights from more than one point, they must be wired so that the terminals at any one switch will be single pole. (See Fig. 8.)

i. Where flush switches or receptacles are used, whether with conduit systems or not, they must be enclosed in an approved box constructed of iron or steel in addition to the porcelain enclosure of the switch or receptacle.

No push buttons for bells, gas-lighting circuits, or the like, shall be placed on the same wall-plate with switches controlling electric light or power wiring.

j. On constant potential circuits all switches controlling circuits supplying current to motors or heating devices, and all cut-outs (except as hereinafter described) must be so arranged that the cut-outs will protect, and the opening of the switch will at one operation disconnect, all the wires; that is, in a two-wire system the two wires and, in a three-wire system, the three wires.

For exceptions as to switches, see the rules under "Motors," "Heating Apparatus," "Electric Cranes," and as to cut-outs, those in this section relating to three-wire systems.

When installed without other automatic overload protective devices, automatic overload circuit-breakers must have the poles and trip coils so arranged as to afford complete protection against overloads and short circuits, and also if used in place of the switch, must be so arranged that no one pole can be opened manually without disconnecting all of the wires.

k. Sad irons and other devices consuming more than 250 watts must not be attached to ordinary 250 watt sockets.

For such work 660 watt sockets will be required unless proper receptacles be provided. Plugs in all cases must be of the pull-out type.

l. Time switches, sign flashers and similar appliances must be of approved design and enclosed in an approved metal cabinet.

m. For potentials above 300 volts, all exposed metal parts, of controlling and protecting apparatus, which do not carry current, must be permanently and effectually grounded.

2. Resistances, Economy Coils, Etc.

a. Resistances, etc., must be so placed, or protected, that the risk of fire will be reduced to a minimum.

The normal working temperature of resistances and similar apparatus is usually high, so that an increase of current will very readily cause serious overheating, liable to set fire to adjacent material, if this be of a combustible nature. Such apparatus must, therefore, be protected by suitable covers of incombustible material, or they must be so placed that the risk of fire will be practically eliminated, either in the event of their being completely burned out, or remaining at an excessive temperature.

They must be placed on a switchboard, or at a distance of at least one foot from combustible material, or separated therefrom by a slab or panel of incombustible, non-absorptive insulating material, such as slate, soapstone or marble, somewhat larger than the rheostat, which must be secured in position, independently of the rheostat supports. Bolts for supporting the rheostat must be countersunk at least one-eighth inch below the surface at the back of the slab, and filled. For proper mechanical strength, the slab should be of a thickness consistent with the size and weight of the rheostat, and in no case less than one-half inch thick.

If resistance devices be installed in rooms where dust or combustible flyings would be liable to accumulate on them, they must be equipped with dust-proof face plates.

Where protective resistances are necessary, in connection with automatic rheostats, incandescent lamps may be used, provided that they do not carry or control the main current, nor constitute the regulating resistance of the device.

When so used, lamps must be mounted in porcelain receptacles upon incombustible supports, and must be so

arranged that they cannot have impressed upon them a voltage greater than that for which they are rated. They must, in all cases, be provided with a name-plate, which shall be permanently attached beside the porcelain receptacle or receptacles, and stamped with the candle-power and voltage of the lamp or lamps to be used in each receptacle.

b. Must be made entirely of incombustible materials, except minor parts such as handles, magnet insulation, etc., of rheostats. All segments, lever arms, etc., must be mounted on incombustible, non-absorptive insulating material.

Rheostats used in dusty or dirty places, or where exposed to flyings of combustible material must be so constructed that, even if the resistive conductor be fused by excessive current, the arc or any attendant flame will be quickly and safely extinguished. Rheostats used in places where the above conditions do not exist may be of any approved type.

c. Wherever insulated wire is used for connection between resistances and the contact plates of rheostats, the insulation must be "slow burning."

For large field rheostats and similar resistances, where the contact plates are not mounted upon them, the connecting wires must be run together in groups so arranged that the maximum difference of potential between any two wires in a group shall not exceed 75 volts. Each group of wires must either be mounted on incombustible, non-absorptive insulators giving at least one-half inch separation from the surface wired over; or, where it is necessary to protect the wires from mechanical injury or moisture, be run in approved lined conduit or its equivalent.

d. For potentials above 300 volts, all exposed metal parts which do not carry current must be permanently and effectually grounded.

3. Heating Apparatus

a. All electric heating apparatus must be so constructed, placed or protected that, whatever rise in temperature may occur, the risk of fire will be practically negligible.

Devices of this description will often require a suitable heat-resisting material placed between them and their surroundings. Such protection may be secured by installing two or more plates of tin or sheet steel with one-inch air space between, or by alternative layers of sheet metal and asbestos, with a similar air space.

b. Must be protected by cut-outs and controlled by indicating switches. Switches must be double-pole unless the device controlled requires less than 660 watts of energy.

This rule must be complied with in the case of apparatus, such as electric cooking ranges, in which several separate heating elements (which are not necessarily required to be in use simultaneously) are employed, by providing a separate cutout to protect each element. Both the cutouts and the switches called for by this rule must be so placed or protected that it will be impossible for anyone to accidentally touch any live parts. (See rule "g" below.)

It is strongly recommended that every electric cooking range be controlled individually by a separate switch capable of entirely cutting off the supply of electric energy.

If the wall receptacle to which any heating or other thermo-electric device is connected be equipped with an indicating switch which entirely cuts off the supply of electric energy, this rule, so far as a controlling switch is concerned, will be considered as complied with, even if the heater or other device consume more than 660 watts.

The foregoing paragraph applies to residences, but in mercantile or manufacturing establishments there must also be in addition to the said switch, a pilot light indicating clearly whether current is on or off.

The receptacle referred to above must not be placed near the floor line or where exposed to injury unless enclosed in a steel cabinet or in a box flush with the finish of the room.

c. Must never be concealed when it is practicable to have them exposed to view, and when concealment is necessary it will only be permitted where there is no risk of fire.

d. For portable heating apparatus the flexible conductors must be connected to an approved plug device, so arranged that the plug will pull out and open the circuit in case any abnormal strain be put on the flexible conductor.

This device may be stationary, or it may be placed in the cord itself. The cable or cord must be attached to the heating apparatus in such manner that it will be protected from kinking, chafing or like injury at or near the point of connection.

e. Smoothing irons, sad irons, and other heating appliances that are intended to be applied to inflammable articles, such as clothing, must conform to the above rules so far as they apply.

They must also be provided with an approved stand, on which they should be placed when not in use.

f. Must each be provided with a name-plate giving the maker's name and the normal rating in volts and amperes.

g. For potentials above 300 volts, all exposed metal parts, which do not carry current, must be permanently and effectually grounded.

In the case of electric cooking ranges and apparatus of a like character this rule must be observed for all potentials both above and below 300 volts.

4. Arc Lamps

a. Must, when used on constant potential circuits, have a cut-out for each lamp, or series of lamps.

The branch conductors must have a current carrying capacity about 50 per cent. in excess of the normal current required by the lamp.

b. Incandescent lamps must not be used as resistances for arc lamps.

c. Where exposed to the flyings of inflammable material, none but the "enclosed" type of arc lamp will be permitted (which must be complete with inner and outer globes), and then only on constant potential circuits up to 650 volts.

In other locations, if outer globes, open at the top, be used, they must be provided with approved spark arresters, or the carbons must be enclosed in a tight-fitting inner globe. If the outer globe be omitted entirely, the carbons must be enclosed in a tight-fitting inner globe.

Inspectors may require a wire netting around the outer globe of arc lamps, where there is evident danger from their being suspended overhead; as an illustration:—in auditoriums, theatres, concert halls, or any building where this form of lighting has been temporarily or permanently installed over an assemblage of people, where falling glass would constitute a serious danger.

d. Where approved hanger-boards are not used, arc lamps, if suspended, must be hung from insulating supports other than their conductors.

e. Arc lamps, when arranged to be raised or lowered, either for carboning or other purposes, must be connected up with stranded conductors from the last point of support to the lamp, when such conductors are larger than No. 14 B. and S. gauge.

f. All arc lamps must be placed out of reach, except in the case of those used for photography or other like purposes.

5. Gas Filled Incandescent Lamps.

a. Must be so grouped that not more than 660 watts (nor more than 16 sockets or receptacles) are to be dependent on

one cut-out, except that in cases where wiring equal in size to No. 14 B. & S. gauge is carried directly into keyless sockets or receptacles, the location of which is such as to render unlikely the attachment of flexible cords thereto, the circuits may be so arranged that not more than 1,320 watts (or 32 sockets or receptacles) will be dependent on the final cut-out. Where a single socket or receptacle is used on a circuit the limitation of watts permissible on the final cut-out shall be the maximum capacity for which such socket or receptacle is approved.

b. Must not be used in show windows or in other locations where inflammable material is liable to come in contact with lamp equipment except where used in connection with approved fixtures where temperature of any exposed portion of same does not exceed 200 degrees Fahr. (93 degrees Centigrade).

c. Must not be used in connection with medium-base sockets or receptacles if of above 200 watts nominal capacity nor with Mogul base sockets or receptacles if of above 1,500 watts capacity. If of above 100 watts, must not, if provided with a shade, reflector, fixture or other enclosure above the socket, be used in either medium or Mogul base types of sockets or receptacles having fibre or paper linings.

d. Fixtures within buildings must be wired with conductors of approved slow-burning or asbestos covering where the temperature to which wire is subjected at any point exceeds 120 degrees Fahr. (49 degrees Centigrade). Where fixtures are placed outside of buildings approved rubber-insulated wire is required.

6. Vapor Lamps

ENCLOSED MERCURY VAPOR LAMPS

a. Must have a cut-out for each lamp, or series of lamps, except where contained in a single frame and lighted by a single operation, in which case not more than five lamps should be dependent upon a single cut-out.

HIGH POTENTIAL VACUUM TUBE SYSTEMS

b. The tube must be so installed as to be free from liability to mechanical injury or contact with inflammable material.

c. High potential coils and regulating apparatus must be installed in an approved steel cabinet not less than one-tenth inch in thickness, and well ventilated in such a manner as to prevent the escape of any flame or sparks in case of burnout in the various coils.

All apparatus in this box must be mounted on a slate base, and the enclosing case must be positively grounded. Supply conductors leading into this high potential case must be installed in accordance with the standard requirements governing low-potential systems, where the potential difference between such conductors does not exceed 300 volts.

7. Portable Lamps

a. When portable lamps are used in places where they would be subjected to mechanical injury, they must be properly protected.

This will require the socket to be attached to a suitable wood or composition handle and metal guard. They must be of a type in which the handle and guard are rigidly secured to one another, and there must be a hook, either on the guard or handle to hang the lamp by, when not in use. They must also be of a type in which the socket, as well as the lamp, is enclosed within the guard.

The rule only applies to portable lamps used in workshops, factories, warehouses, and places where such protection is necessary, and does not include portable lamps of the desk type, used in offices, residences and similar places, where the portable lamp is in the form of a fixture equipped with a heavy base.

In Fig. 9, the type of guard described above is suitably illustrated, but other equally effective designs will be accepted.

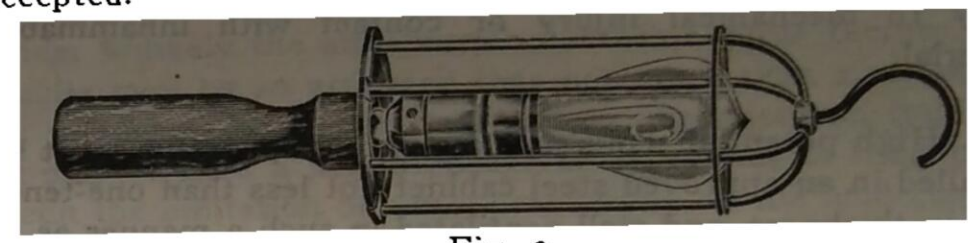

Fig. 9

8. Cabinets

(For Panel and Distributing Boards, Cut-outs and Switches)

DESIGN

a. Must be in all cases so constructed as to ensure ample strength and rigidity, and be dust tight.

The hard usage to which cabinets are often subjected, especially during the process of installation, makes it necessary so to construct them that they will be strong enough to keep their shape, thus permitting doors to close tightly and making possible the proper installation of wiring and conduit.

When doors are of metal, and less than 0.109 inch (No. 12, U. S. sheet metal gauge) in thickness, and are not lined with insulating material, there must be a space of at least one inch between the door and an enclosed fuse, or any exposed live metal part.

Except as specified above, there must be, in all cases, a space of at least one-half inch between the walls, back or door of any cabinet and any exposed live metal part. Cabinets must be deep enough to allow the door to be closed, when switches, rated at 30 amperes or less, are in any position, and when larger switches are thrown open, as far as their construction or installation will permit.

MATERIAL

b. May be either of cast or sheet metal, wood or approved composition, as follows:—

For metal conduit, armoured cable, or metal moulding work, only metal cabinets may be used.

For distributing centres, such as pockets for cut-outs and switches in "knob and tube" work, wood may be used, but must be lined with one-eighth inch solid asbestos card.

For the enclosure of sign flashers, or any other apparatus, metal cabinets must be used.

For open wiring, under "ordinary conditions," wooden cabinets may be used for enclosing switches or cut-outs, but for all apparatus only metal may be employed.

Asbestos lumber may be used instead of lined wood, wherever wood is permitted.

WOODEN CABINETS

c. Wood must be well seasoned and at least three-fourths of an inch in thickness, and be thoroughly filled and painted, and must be lined with an incombustible material as called for.

LININGS

d. In all cabinets, linings of slate, marble or approved composition must be at least one-fourth of an inch thick and firmly secured in place; when metal is used for the lining it must be at least No. 16 U. S. sheet metal gauge in thickness.

For lining wooden cabinets one-eighth inch rigid asbestos board may be used when firmly secured in place by screws or tacks.

COMPOSITION CABINETS

e. Only approved material may be used, which must be in no case less than three-fourths of an inch in thickness.

METAL CABINETS

f. If cast metal be used, a thickness of at least one-eighth of an inch must be provided. Sheet metal must not be less

than .0625 inch thick (No. 16 U. S. sheet metal gauge), and must in every case be of sufficient thickness or so reinforced as to comply with Rule "a."

In steel cabinets having an area of more than 360 square inches for any surface, or having a single dimension greater than 2 feet, sheet metal must be used at least No. 14 U. S. sheet metal gauge in thickness; in those having an area of more than 1,200 square inches for any surface, or having a single dimension greater than 4½ feet, the sheet metal must be at least No. 12 U. S. sheet metal gauge in thickness.

DOORS

g. Must close against a rabbet or have flanges over edges so as to make cabinets dust-tight.

Hinges must be of strong and durable design. A substantial latch or catch must be provided, so as to keep the door closed, and a lock may be used in addition to the catch if desired.

When doors have glass panels the glass must be at least one-eighth inch thick (commercial thickness) and must not have a greater area than 450 square inches, unless plate-glass at least one-fourth inch in thickness is used.

9. Fixtures

a. Fixtures must not, except as hereinafter described, be wired with less than No. 18 B. and S. gauge wire, which must have an approved insulating covering.

This rule will be strictly enforced except that, in the case of small fixtures, where it is impossible to have the stems or arms large enough to contain No. 18 B. and S. gauge wire; No. 20 wire will be permitted as a minimum. This refers to the wiring of delicate fixtures and small figures where their use is confined to residences, or other places where they would be likely to receive equally careful treatment, and where they would also be free from mechanical injury and

moisture. Such wires must be wholly contained within the fixture, and must not be damaged in drawing in.

In wiring certain designs of show-case fixtures, ceiling bull's eyes and other appliances in which the wiring may be exposed to temperatures in excess of 120 deg. Fahr., from heat of the lamps or other causes, a slow-burning insulating covering must be used. All such forms of fixtures must be submitted for examination, test and approval before being installed for use.

b. Supply conductors, and especially the splices to fixture wires, must be kept clear of the grounded part of gas pipes, and where shell or outlet boxes are used, they must be made sufficiently large to allow the fulfilment of this requirement.

c. Wires must, when on the outside of a fixture, be so secured as not to be cut or abraded by the pressure of the fastenings or motion of the fixture.

d. Under no circumstances must there be a difference of potential of more than 300 volts between wires contained in, or attached to, any fixture.

e. When supported from any grounded metal work, or when installed on metal walls or ceilings, or on plaster walls or ceilings containing metal lath, or on walls or ceilings in fire-proof buildings, fixtures must be insulated from such supports by approved insulating joints placed as close as possible to the ceilings or walls.

The insulating joint may be omitted in conduit, armoured cable or metal moulding systems with straight electric fixtures in which the insulation of conductors is equivalent to the insulation in other parts of the system, and provided that approved sockets, receptacles or wireless clusters are used of a type having porcelain or equivalent insulation between live metal parts and outer metal shields if any.

Wires must be protected above the insulating joint by approved insulating tubing, and where such tubing is used it must be of sufficient length to extend below the insulating

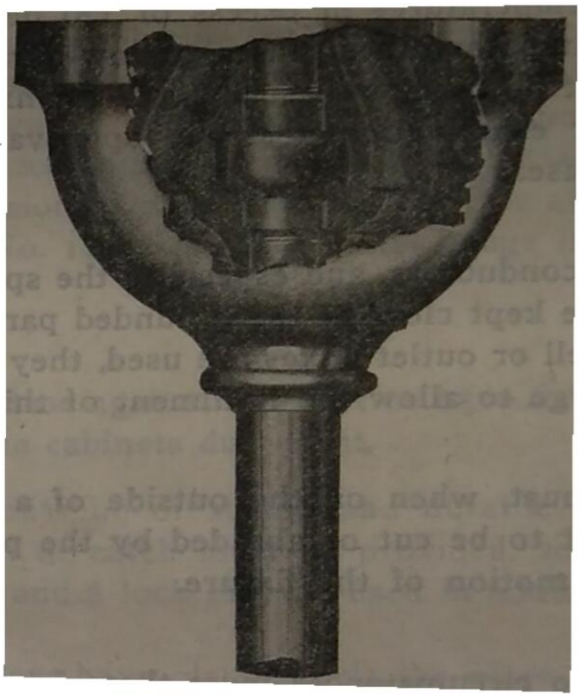

Fig. 10.

joint, and must be so secured that it will not be pushed back when the canopy is put in place. (See Fig 10.)

When insulating joints are required, fixture canopies of metal, in fire-proof buildings, must be thoroughly and permanently insulated from metal walls or ceilings, or from plaster walls or ceilings on metal lathing.

f. Canopies and back plates of all fixtures must be so designed as to afford ample room for joints, and they must be readily removable for purposes of inspection.

For instance, if a so-called flat backplate be furnished with any fixture, it must be provided with a suitable outlet box of sufficient size, which can be let into the wall or ceiling; to provide only the backplate and cut a hole behind it in plaster or brickwork, etc., will not be approved.

The use of approved splicers in place of joints in fixture canopies will be permitted.

g. Fixtures must be made of metal or hardwood, except that other approved material may be used if re-inforced with metal or otherwise so constructed as to ensure requisite mechanical strength.

In all cases the mechanical strength must be practically equivalent to an all-metal fixture of similar size and form.

h. All arms must be reliably secured to prevent turning. Arms of threaded tubing must not be lighter than No. 18 B. & S. gauge, and with screw joints of arms there must be not less than five threads, all engaging.

All methods of fastening arms or making joints between metal parts by soldering, brazing or otherwise, must be such as to ensure in every case ample strength and reliability.

i. No canopy or other part of any fixture must contain a receptacle or other device having any exposed live parts.

j. All burrs, fins and sharp edges, liable to injure wire coverings must, where practicable, be removed or rounded, but in every case it must be possible to pull in and also to withdraw the wires without injuring them.

Where supply wires enter fixture stems or casings there must be suitable bushings, having smooth, rounded edges, to prevent injury to the wire coverings.

Where fixtures are made of wood, or other combustible material, wireways must be metal lined unless approved armoured conductors, with suitable fittings, be used.

On chains or similar parts, where conductors are not completely enclosed in metal they must be stranded and must have rubber insulation not less than one-sixty-fourth of an inch in thickness, or pendant cord may be used.

10. Flexible Cord

a. Must have an approved insulation and covering.

Under this rule not only must flexible cord be what is known as "approved," but it must be of a type approved for the purpose for which it is to be used.

b. Must not, except where permitted in street railway property, be used where the difference of potential between the wires is over 300 volts.

c. Must not be used as a support for clusters, nor must any device be attached which will impose an injurious strain on either the cord or fittings.

d. Must not be used except for pendants, wiring of fixtures, portable lamps or motors, and portable heating apparatus.

For all portable work, including those pendants which are liable to be moved about sufficiently to come in contact with surrounding objects, flexible wires and cables, especially designed to withstand this severe service, must be used.

e. In show windows ordinary flexible cord must not be used unless it be enclosed in metal armour or in a rigid fixture.

The use of reinforced cord will, however, be permitted in conjunction with ⅜" sockets. Chain fixtures are permissible if wired with approved flexible conductors. It is also required that rosettes and receptacles used in show windows shall not have any exposed live parts.

f. Must be protected by insulating bushings where the cord enters the sockets, or at similar points in other devices, if not otherwise protected.

g. Must be so suspended that the entire weight of the socket and lamp will be borne in some approved manner

under the bushing in the socket, and above the point where the cord comes through the ceiling block or rosette, in order that the strain may be taken from the joints and binding screws.

h. Except as provided under "Fixtures," must never be of less size than the equivalent of No. 18 B & S. gauge.

11. Floor Receptacles

a. In all conduit and armoured cable work, except as indicated below, floor receptacles must be of the type known as watertight.

In residential work ordinary approved outlet boxes may be used, with self-closing receptacles, on varnished, waxed or carpeted floors whether the wiring be knob and tube or conduit.

Water-tight boxes generally consist of a solid cast-iron box threaded to receive the conduit pipe and provided with a form of plug which is protected from mechanical injury by a stout brass shield which screws into the top plate of the box through which the cord enters. When not in use this metal shield can be screwed out and a flat disc screwed into its place, leaving a smooth, flat, watertight surface, even with the floor.

In other than conduit and armoured cable work, floor boxes must be as approved for switches and receptacles, and the receptacle must be of the self-closing protected plug type.

This requires a form of plug which is reinforced by some rigid and substantial means which will protect the removable part from mechanical injury and in which the openings will automatically close tight when the removable part is withdrawn.

12. Conductors

ALLOWABLE CURRENT-CARRYING CAPACITIES

a. The following table, showing the allowable current-carrying capacity of copper wires and cables of ninety-eight per cent. conductivity according to the standard adopted by

the American Institute of Electrical Engineers, must be followed in selecting interior conductors.

For insulated aluminum wire the safe current-carrying capacity is sixty-one per cent. of that given in the following tables for copper wire, with the same kind of insulation.

The lower limit is specified for rubber-covered wires to prevent gradual deterioration of the high insulations by the heat of the wires, but not from fear of igniting the insulation. The question of voltage drop is not taken into consideration in these tables. (See "Useful Data," paragraph "b," and Table "A," page 137.)

	Table A Rubber Insulation	Table B Other Insulations	
B. & S.G.	Amperes	Amperes	Circular Mils
18	3	5	1,624
16	6	10	2,583
14	15	20	4,107
12	20	25	6,530
10	25	30	10,380
8	35	50	16,510
6	50	70	26,250
5	55	80	33,100

	Table A Rubber Insulation	Table B Other Insulations
B. & S. G.	Amperes	Amperes	Circular Mils
4	70	90	41,740
3	80	100	52,630
2	90	125	66,370
1	100	150	83,690
0	125	200	105,500
00	150	225	133,100
000	175	275	167,800
0000	225	325	211,600

Circular Mils		
200,000	200	300
300,000	275	400
400,000	325	500
500,000	400	600
600,000	450	680
700,000	500	760
800,000	550	840
900,000	600	920
1,000,000	650	1,000
1,100,000	690	1,080

Circular Mils		
1,200,000	730	1,150
1,300,000	770	1,220
1,400,000	810	1,290
1,500,000	850	1,360
1,600,000	890	1,430
1,700,000	930	1,490
1,800,000	970	1,550
1,900,000	1,010	1,610
2,000,000	1,050	1,670

In lighting installations the maximum allowable voltage drop in the conductors, between service cut-outs and the

most distant point, should not exceed 2½ per cent. of the nominal supply voltage when all lamps are on.

The limit here given must not be too closely approached in new installations, as it will always be necessary to make due allowance for possible future extensions and increased load.

In regard to power installations the limiting factor to be observed will, generally, except where long runs are necessary, be the current-carrying capacity as given in the tables under "Conductors." as this is in all cases based on the maximum permissible rise of temperature.

II. WIRING UNDER ORDINARY CONDITIONS

1. General

a. Wires must not be of a smaller size than No. 14 B. and S. gauge, except as allowed for fixture work and pendant cord.

b. In all three-wire installations the three wires must be of the same gauge or current carrying capacity.

c. For tie wire only approved insulated wire must be used.

d. Wires must be so spliced or joined as to be both mechanically and electrically secure without solder.

The joints must then be soldered, unless made with some form of approved splicing device, and covered with an insulation equivalent to that on the conductors.

e. Stranded wires (except in flexible cords) must be soldered before being fastened under clamps or binding screws and whether stranded or solid, when they have a conductivity greater than that of No. 8 B. and S. gauge copper wire, they must be soldered into lugs for all terminal connections, except where an approved solderless terminal connector is used.

f. Wires must be separated from contact with walls, floors, timbers or partitions through which they pass by tubes of incombustible, non-absorptive, insulating material, such as glass or porcelain, excepting at outlets, where approved flexible tubing is required.

Bushings must be long enough to bush the entire length of the hole in one continuous piece, and each end must project at least half an inch, or else the hole must be first bushed by a continuous water-proof iron tube. This tube may be a conductor, such as iron pipe, but in that case an insulating bushing must be pushed into each end of it, extending far enough to keep the wire absolutely out of contact with the pipe. Such bushings must be properly secured in position. (See Fig. 11.)

g. Conductors, when not protected by approved conduit, moulding or armouring, and where liable to come in contact with gas or water pipes or other conducting material, must be separated therefrom, by some continuous and firmly fixed non-conductor, creating a permanent separation.

They must not come nearer than six inches to any other electric lighting, power or signalling wire, not protected as above, without being permanently separated therefrom by some continuous and firmly fixed non-conductor.

The non-conductor used as a separator must be in addition to the regular insulation on the wires.

Where tubes are used they must be securely fastened at the ends to prevent them from moving along the wires.

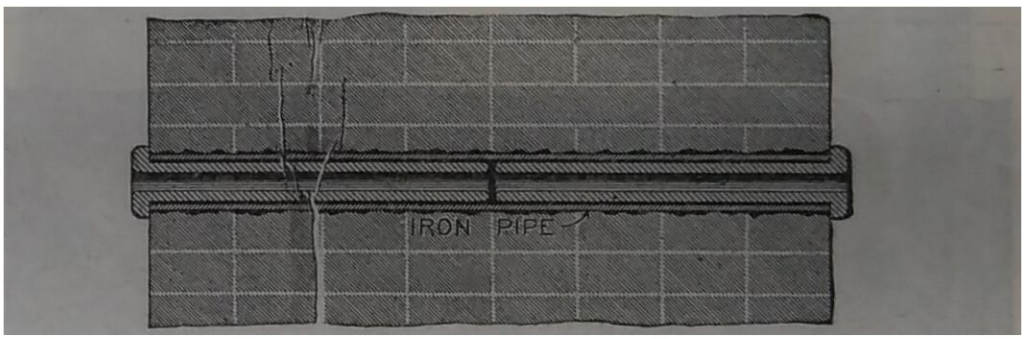

Fig. 11

h. Conductors must be so arranged in wet places that an air space will be left between them and pipes or other obstructions in crossing, and must be run in such a way that they cannot come in contact with such obstructions accidentally.

Wires should be run over, rather than under, pipes, etc., upon which moisture is likely to gather and which might, therefore, cause trouble on a circuit.

i. Wires must not be run in elevator shafts where the potential exceeds 650 volts, and below this potential they must be run in approved conduit, or armoured cable must be employed.

j. Must be rigidly supported on incombustible, non--absorptive insulators, which will separate the wires from each other, and from the surface wired over, in accordance with the following table:—

Voltage	Distance from surface	Distance between wires
10 to 300	½ inch	2½ inches
301 to 650	1 inch	4 inches
651 to 2,500	2 inches	6 inches
2501 to 5,000	3 inches	9 inches

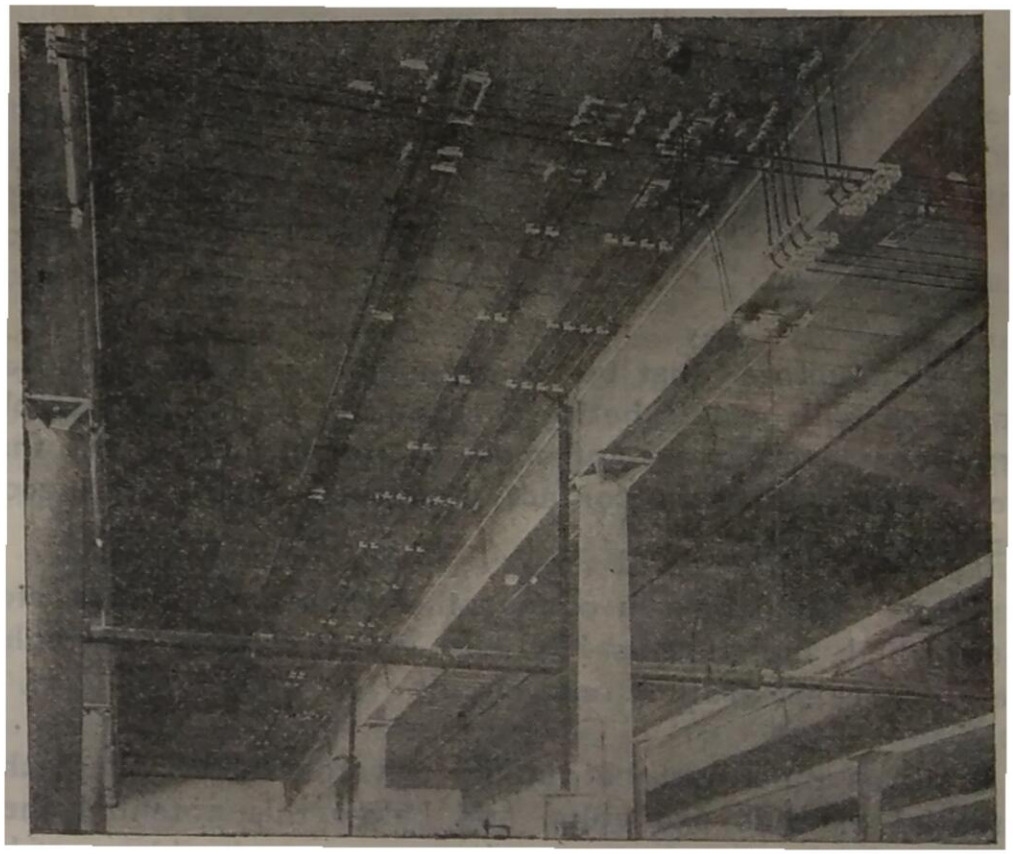

Fig. 12

Rigid supporting requires, under ordinary conditions, where wiring along flat surfaces, supports at least every four and one-half feet. If the wires are liable to be disturbed, the distance between supports must be shortened. In buildings of mill construction, mains of not less than No. 8 B. and S. gauge, where not liable to be disturbed, may be separated about six inches, and run from timber to timber, not breaking around, and may be supported at each timber only. (See Figs. 12 and 13.)

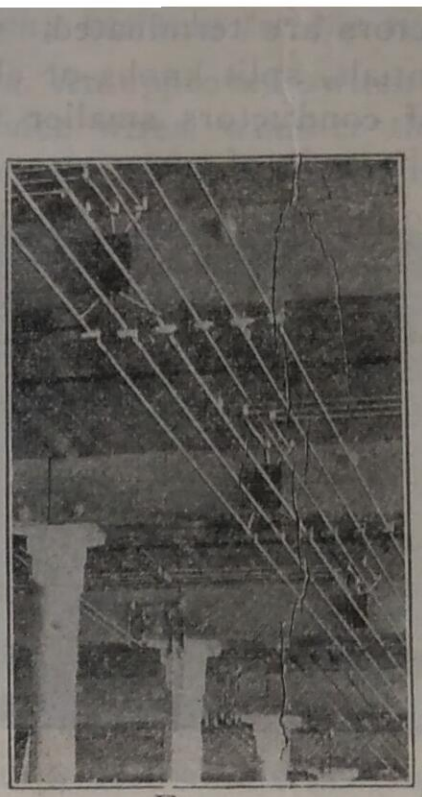

Fig. 13

Fig. 14

k. Must not be "dead-ended" at a rosette, socket or receptacle, unless the last support is within twelve inches of the same.

This is in order to relieve terminals of strain due to the weight or pull of conductors. In no case, however, must any wire, if accidentally disconnected from its terminal, be liable to come into dangerous proximity to any conducting

material. A similar precaution must be taken wherever one conductor is tapped off another, as in "T" joints and cord pendants, in order that the point of junction may be relieved from strain. (See Fig 14.)

l. **Wires of No. 8 B. and S. gauge or over must not be supported on split knobs.**

Solid knobs or strain insulators must be used for all wires at the ends of runs where conductors are terminated. (See Fig. 15.) Except with high potentials, split knobs or cleats must be used for the support of conductors smaller than No. 8 B. and S. gauge, except at the ends of runs.

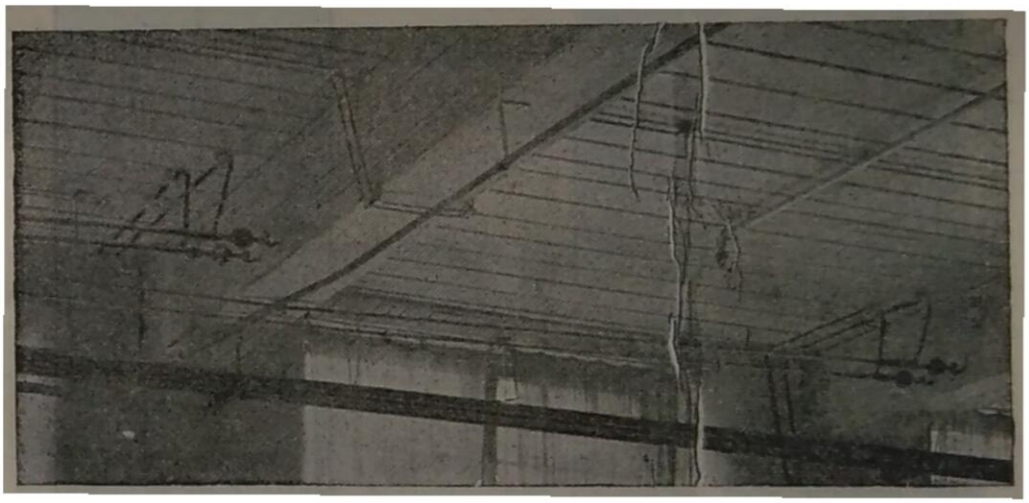

Fig. 15

Knobs or cleats which are arranged to grip the wire must be fastened by screws, which must be long enough to penetrate the woodwork not less than one-half the length of a knob and fully the thickness of a cleat. The screws must be of the largest gauge appropriate to the holes in the insulators.

m. Unused ends of insulated conductors, such as those at switch and fixture outlets, must not be left uninsulated.

n. In dark rooms, lavatories, basements and places where a person would be liable to receive a shock when handling electric fittings, the shells of sockets, switches, plugs and receptacles must be of porcelain or other approved insulating material, unless the fixtures or sockets, etc., are out of

reach or controlled by wall switches placed outside of the danger zone.

2. Services and Service Meters

Under this heading are included rules covering the installation of all service wires, either overhead or underground, and the fittings in connection therewith, brought into or attached to any building for the supply of electrical energy thereto.

a. An approved switch and cut-out must be placed on all service wires, whether these be overhead or underground. Such switch and cut-out must be located inside the building at the nearest accessible point to the place where the service wires enter, and they must be arranged to cut off the entire current from the circuits which they control.

On all service switches the "open" and "closed" positions must be plainly indicated.

The arrangement of cut-out and switch must be such that the service wires first enter the former.

In private plants, **the yard wires** running from building to building are not considered as service wires, so that switches and cut-outs would not be required in each building at the point of entry, provided that:—

1. There are other switches conveniently located on the mains, or that the generators are at hand.

2. The next cut-out back is small enough to properly protect the wires inside the building in question.

b. Service cut-outs must always be enclosed in an approved iron or steel box and sealed under the control of the supply authority, which seal must not be broken except by an inspector having jurisdiction or by an authorized agent of the supply authority.

This will not prevent the consumer from controlling his own branch fuses, or even auxiliary service fuses, but the main source of supply must be equipped with fuses under seal.

In order to obviate the inconvenience which would otherwise be caused, should the service fuses blow rather than the

consumer's own fuses, the former may be of slightly higher rating than that which would be necessary under Rule "f" "Controlling and Protecting Apparatus."

Under this rule, in premises where tenants installations are separately metered or supplied from separate sub-mains, each such installation will be considered as an individual service and must be equipped as such unless the service equipment be in the form of an approved switchboard or metering panel under the control of a skilled person or persons and not accessible to any others.

Snap switches must not be used on services unless they are an integral part of an approved steel service box.

c. All live parts of service equipment, including cut-outs, switches and meters, must be so protected that accidental contact therewith will be effectually prevented.

By reference to Fig. 19 will be seen an approved form of service box, which is recommended on all services up to 30 amperes not exceeding 250 volts. This box is designed to contain the main fuse under seal, the service switch is also enclosed, and the box is further provided with a compartment for double or single cut-out, thereby completely fulfilling all requirements of both Rules "b" and "c" under "Services and Service Meters."

Where such apparatus is located in any portion of a building, not accessible to other than authorized persons, such as the electric service room, engine room, or any similar location, where it would be under the care and operation of skilled persons, or people familiar with the nature of such apparatus, it will be considered as complying with the rule. In other locations, such as residences, or any other building where *anyone* might come accidentally in contact with live parts, or where conducting material might be liable to fall across the live parts, or to be otherwise accidentally brought into contact with them, such apparatus must be thus enclosed.

d. Must be protected against moisture and mechanical injury, and all combustible material must be kept from the immediate vicinity of the point of entrance in a building.

Only petticoat insulators must be used on that portion of

an overhead service which lies outside the building or is in any way exposed to the weather. Such insulators must never be placed at an angle of more than 45 degrees to the vertical, reckoned from their normal position.

e. Not more than one service of the same potential must be run from overhead into any building from the same system, except as hereinafter provided.

Unless it can be demonstrated that compliance with this requirement, in any particular instance, is impracticable, the rule must be observed.

This rule is to prevent indiscriminate and unnecessary multiplication of services entering buildings from overhead, which becomes a serious menace to firemen and greatly increases the risk of fire to the building itself.

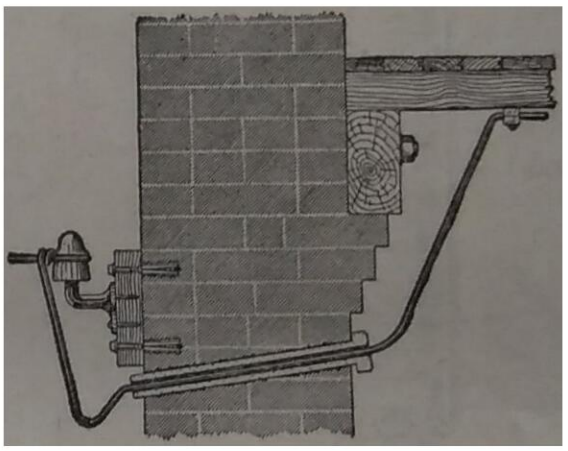

Fig 16

Suitable stand pipes must, therefore, be installed in any building where electric services are required in various parts thereof.

f. Where overhead service wires are permitted, by the Inspection Department, to enter buildings, as per Fig. 16, they must at the point of entry have drip loops outside, and the holes through which the conductors pass must be bushed with incombustible, non-absorptive, insulating tubes slanting upwards towards the inside. (See Fig. 16.)

Where possible, these tubes must be kept apart a distance of not less than 12 inches; in no case less than 6 inches for

low potentials, and never less than 12 inches for high potentials.

g. If low potential service wires be brought into buildings, as per Fig. 17, through a single iron conduit, the conduit must be not less than ¾" internal diameter and must be equipped with an approved service head. (See Fig. 17.)

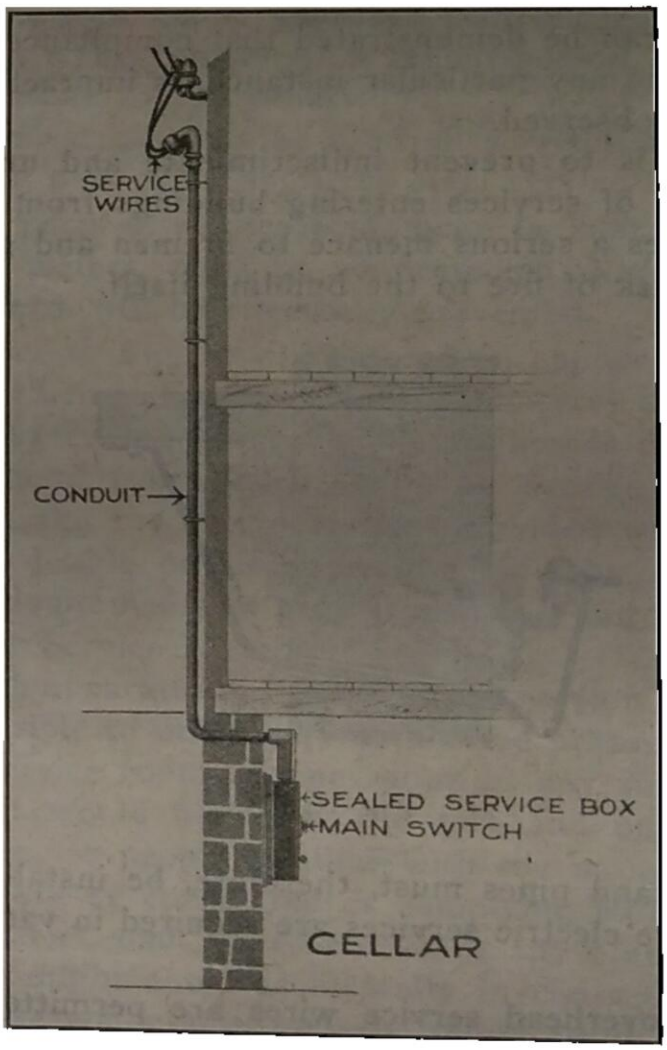

Fig. 17

Showing an overhead service brought into the basement of a building as required under Rule "f". This pipe to enter the iron service box with none of the service wires exposed and to be effectually and permanently grounded.

Great care must be exercised in bringing service wires through conduit, especially where such wires are not pro-

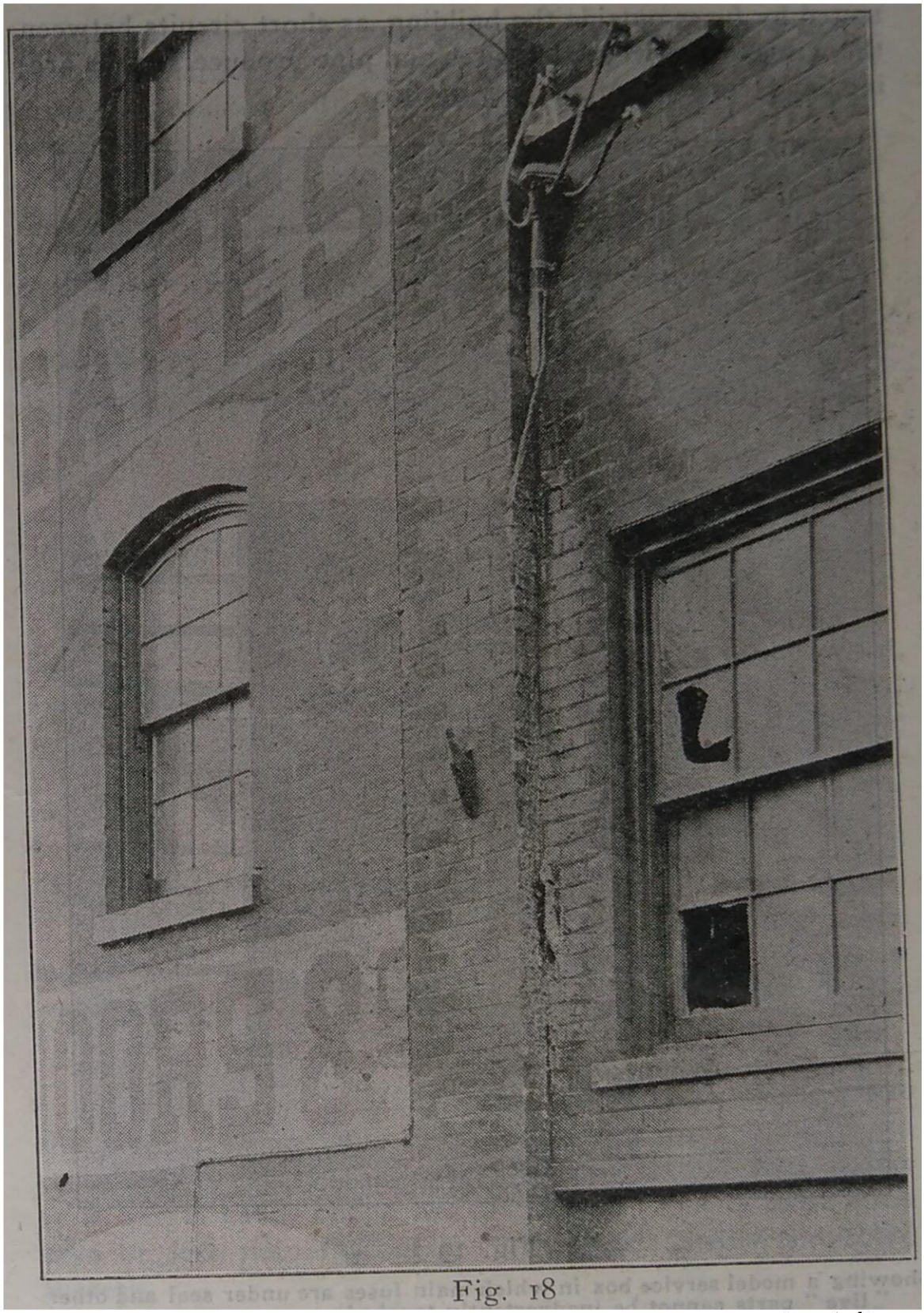

Fig. 18

Showing damage done by a "Burn Out" inside a Service Conduit.

tected by fuses outside the building, as short circuits between the wires or between the wires and pipe produce serious arcing, and consequent danger of fire.

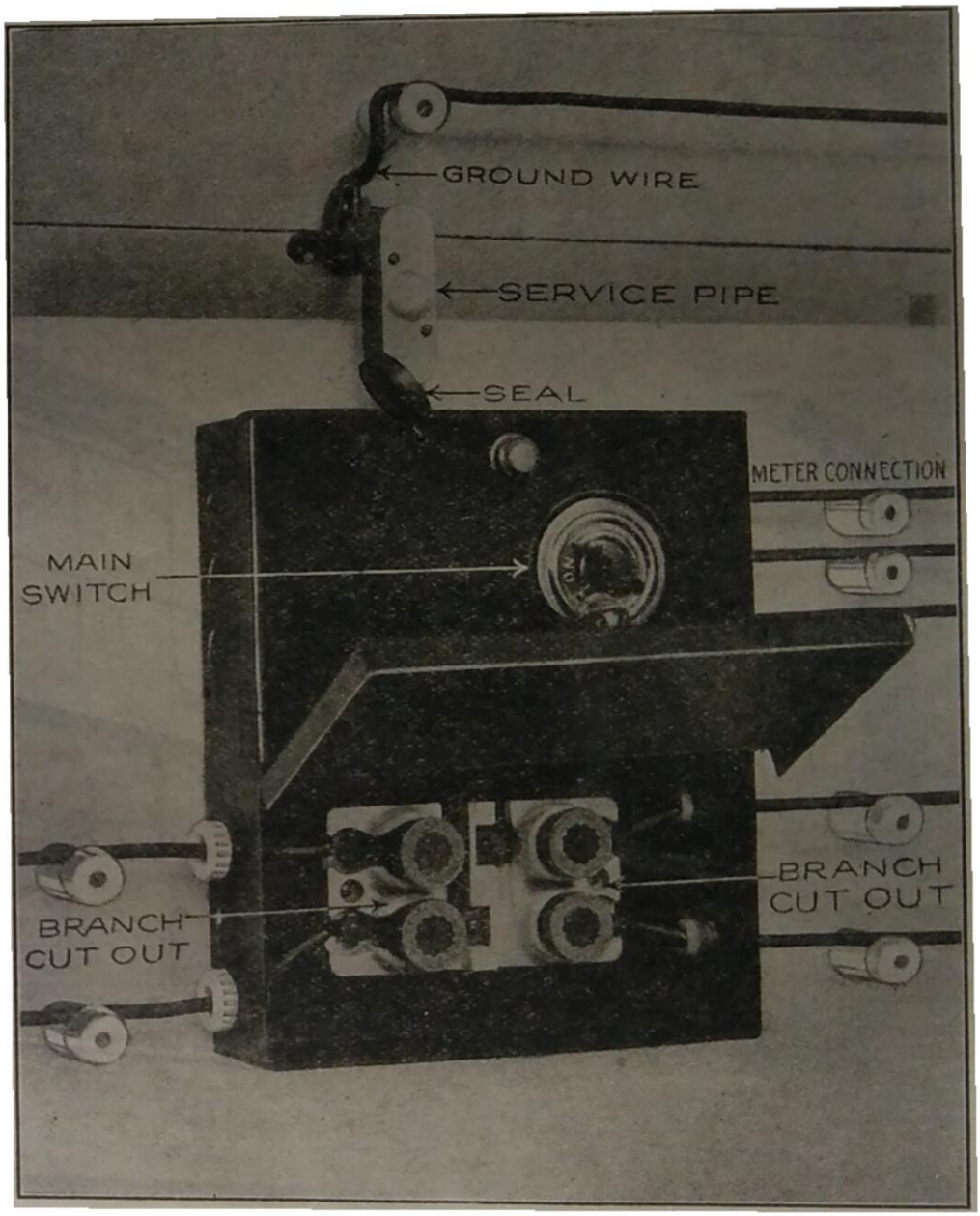

Fig. 19

Showing a model service box in which main fuses are under seal and other "live" parts cannot be inadvertently touched.

Special care must be taken when drawing in conductors to prevent any abrasion of the insulation, and the joints in the pipe must be water-tight. (See Fig. 18.)

In all cases where low potential service wires are carried into or out from buildings in metal conduit, the outside end must be provided with a weatherproof fitting which separately bushes each wire.

The inside end must be carried directly into the service box in such a way that the length of service pipe between its point of entrance into the building and the box is reduced to a minimum. In other words, there must be no more conduit projecting through the wall than is required for direct attachment to the service box either by threading or lock-nuts. (See Fig. 19.)

In all cases the pipe must be securely attached to the outside wall of building, and, unless circumstances will not permit, it must be continued up, so that the service head will be at least 20 feet from the ground. The pipe is to be permanently and effectually grounded as for conduit systems.

Where short lengths of conduit are used to bring in service wires, the same general precautions must be observed, except that, where the potential does not exceed 650 volts, and where they cannot be reached from the ground outside, or touched by a person standing on or in contact with any material, either inside or outside the building through which anyone would be liable to receive a shock, such short lengths need not be grounded.

All holes made in walls for the insertion of service pipes must be effectually closed around the pipe, so as to prevent water from following along the outside of the pipe into the building.

h. That portion of service wires from service cut-outs to the point at which they join an aerial service must, in no case, have a current-carrying capacity less than that of No. 12 B. and S. gauge copper wire, and such capacity must in no case be less than that of the consumer's mains connected thereto.

i. Where the difference of potential between any two wires or between any wire and ground, in a service pipe, is

between 10 and 650 volts, such wires must comply with all requirements governing conduit work.

This rule is necessary, owing to the fact that service wires usually are not protected, as is the case with inside wires, and any short circuit between wires and the pipe, or leakage to ground, may result in serious damage. The rule, therefore, requires double-braided, rubber-covered wire stranded in all sizes over No. 12 B. & S. gauge, and not drawn in until all mechanical work on the pipe is finished.

j. Where the difference of potential is between 650 and 5,000 volts, and where services from overhead lines are brought into buildings, the following requirements must be observed:—

1. The point where overhead wires enter conduit must not, where practicable, be less than 20 feet from the ground.

2. Conductors must be lead sheathed, and the insulation must, in no case, be of a grade lower than that required for 5,000 volts.

3. Conduit and sheathing must be well bonded, and permanently and effectually grounded.

4. Must, where wires issue from sheathing, be protected from moisture by a pot-head, or other approved device.

5. Service wires must be so located that they cannot be reached from any window or balcony, or other points wherefrom any unauthorized persons might be able to touch them; or otherwise they must be properly protected, so that the same object will be attained.

k. Must not be so arranged as to shunt the current through a building around any catch-box.

1. Where an underground service enters a building through tubes, the tubes must be tightly closed at outlets with asphaltum or other non-conductor, to prevent gases from entering the building through such channels.

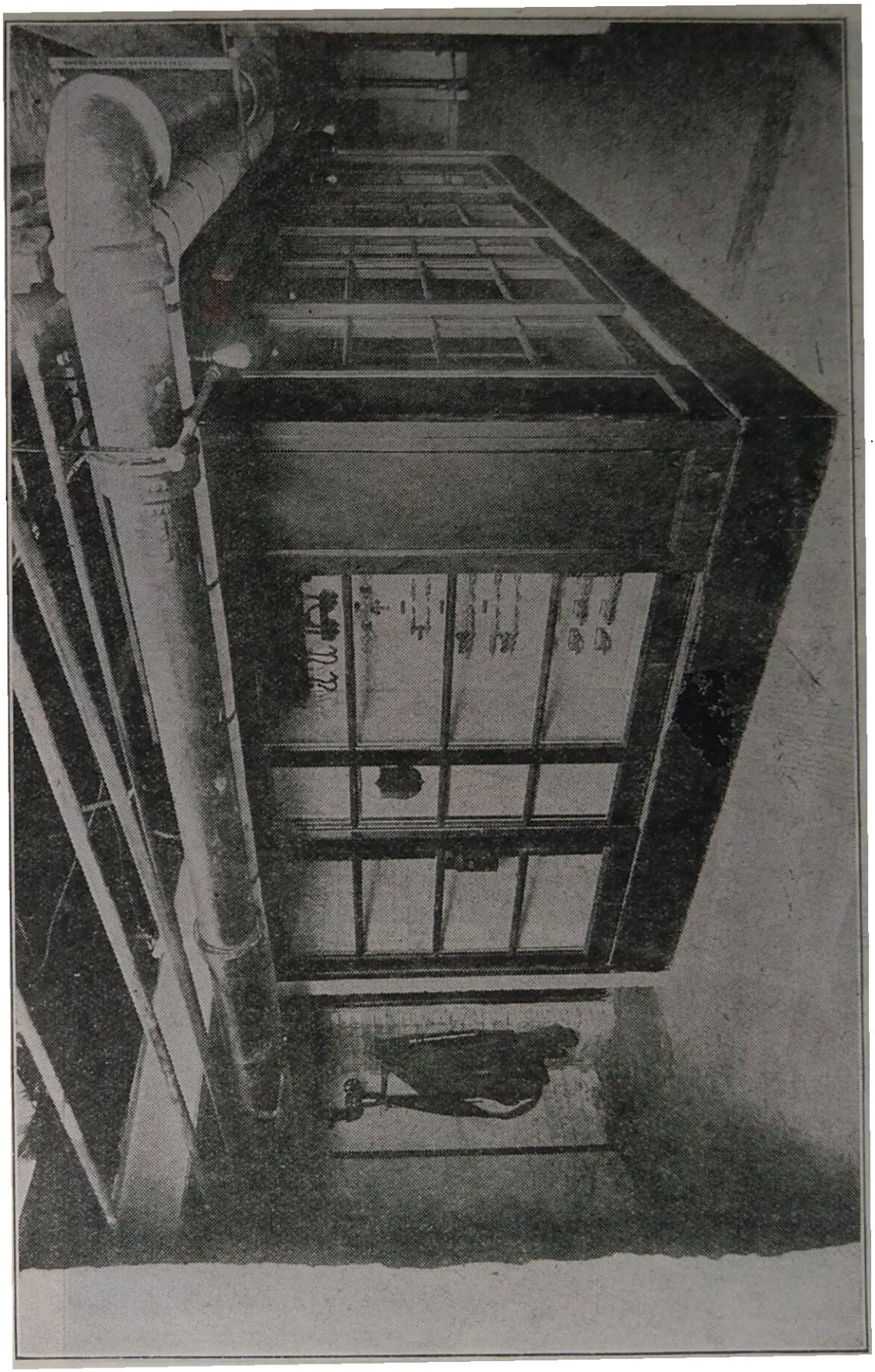

Fig. 20

Showing a well arranged Main Meter Panel in large office building enclosed in steel and wire glass enclosure.

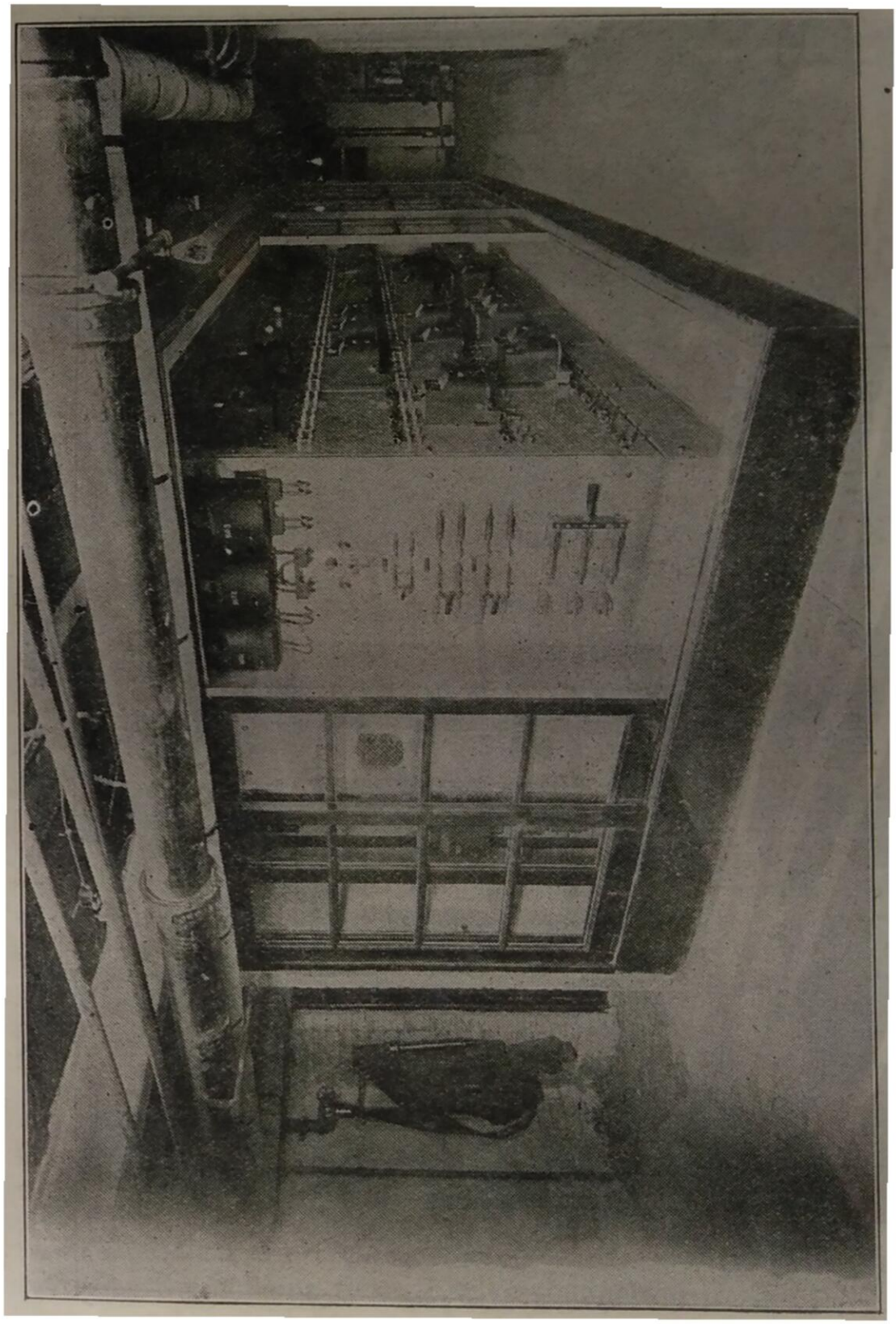

Fig. 21

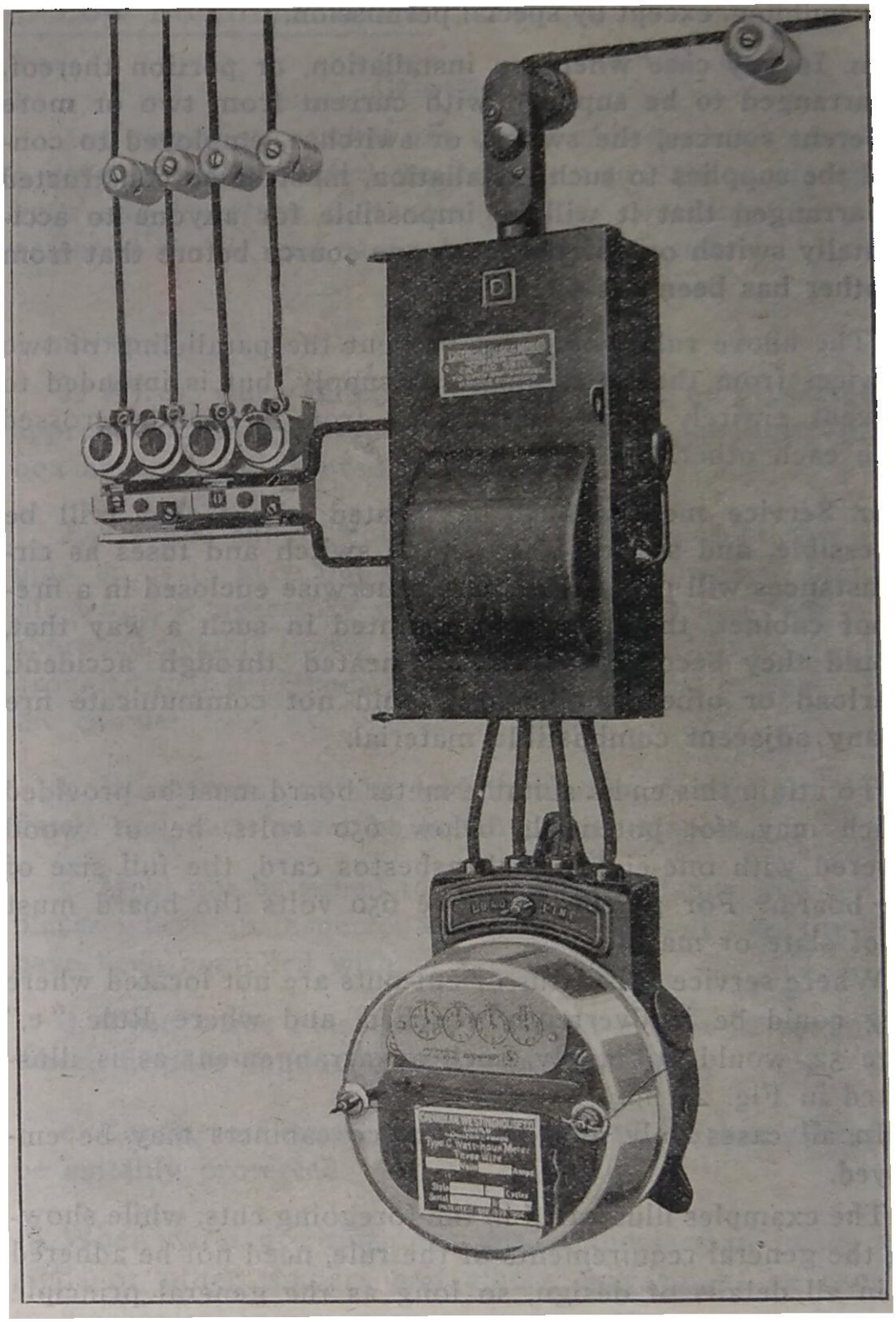

Fig. 22

m. No single underground service shall supply more than one building, except by special permission.

n. In any case where an installation, or portion thereof, is arranged to be supplied with current from two or more different sources, the switch, or switches, employed to control the supplies to such installation, must be so constructed or arranged that it will be impossible for anyone to accidentally switch on current from one source before that from another has been cut off.

The above rule would not prevent the paralleling of two services from the same source of supply, but is intended to prevent entirely different systems from becoming crossed with each other.

o. Service meters must be located where they will be accessible, and as near the service switch and fuses as circumstances will permit. Unless otherwise enclosed in a fireproof cabinet, they must be mounted in such a way that, should they become abnormally heated through accident, overload or other cause, they could not communicate fire to any adjacent combustible material.

To attain this end a suitable meter board must be provided which may, for potentials below 650 volts, be of wood covered with one-eighth inch asbestos card, the full size of the board. For potentials above 650 volts the board must be of slate or marble.

Where service apparatus or cut-outs are not located where they could be inadvertently touched, and where Rule "c," page 52, would not apply, such an arrangement as is illustrated in Fig. 22 may be adopted.

In all cases only approved service cabinets may be employed.

The examples illustrated in the foregoing cuts, while showing the general requirements of the rule, need not be adhered to in all details of design, so long as the general principle is carried out. For instance, the cabinet, shown in Fig. 19, might be made large enough to accommodate not only the main switch and fuses, but also a number of branch cut-outs.

3. Low Potential Work

(10 to 650 Volts)

Any circuit attached to any source of power which develops a difference of potential, between any two wires, of over 10 volts and less than 650 volts, shall be considered as a low potential circuit, and as coming under this class.

1. GENERAL

a. Wires, when entering cabinets, must be protected by approved bushings, which must tightly fit the holes in the box and be well secured in place.

The wires should completely fill the holes in the bushings, so as to keep out dust; tape may be used to build up the wires, if necessary. In concealed knob and tube work, approved flexible tubing will be accepted in lieu of bushings, provided that it extends from the last porcelain support into the cabinet.

b. Wires must not be laid in plaster, cement or similar finish, and must never be fastened with staples.

c. Must not be fished for any great distance, and only in places where an inspector can satisfy himself that the rules have been complied with.

d. Twin wires must never be used except in conduit or where flexible conductors may be necessary.

e. Conductors must, where exposed to mechanical injury, be suitably protected.

When wires are run open across the face of joists, wall studs or other timbers and where they might be exposed to mechanical injury, such as in basements or other places not remote from such injury, they must be attached by their insulating supports to the underside of a wooden strip, not

less than one-half inch in thickness, and not less than four inches in width. Instead of running-boards, guard strips on each side of, and close to, the wires will be accepted. These strips are to be not less than seven-eighths of an inch in thickness, and at least as high as the insulators. (See Fig. 23.)

Protection on side walls must extend not less than five feet from the floor, and must consist of substantial boxing, retaining an air space of not less than one inch around the conductors, closed at the top (the wires passing through bushed holes), or approved metal conduit or pipe of equivalent strength must be used.

When metal conduit or pipe is used, the insulation of each wire must be reinforced by approved flexible tubing extending from the insulator next below the pipe to the one

Fig. 23

next above it, unless the conduit be installed according to the rules on conduit wiring (Rules "c" and "e" thereof excepted) and the wire is approved for conduit use. The two or more wires of a circuit, each with its flexible tubing (when required), must be placed within the same metal pipe. Special permission for deviation from this last requirement may be granted in the case of direct-current circuits.

In damp places, varnished wooden boxing may be preferable, because of the precautions which would be necessary

to secure proper insulation if metal pipe were used. With this exception, however, metal piping is considered preferable

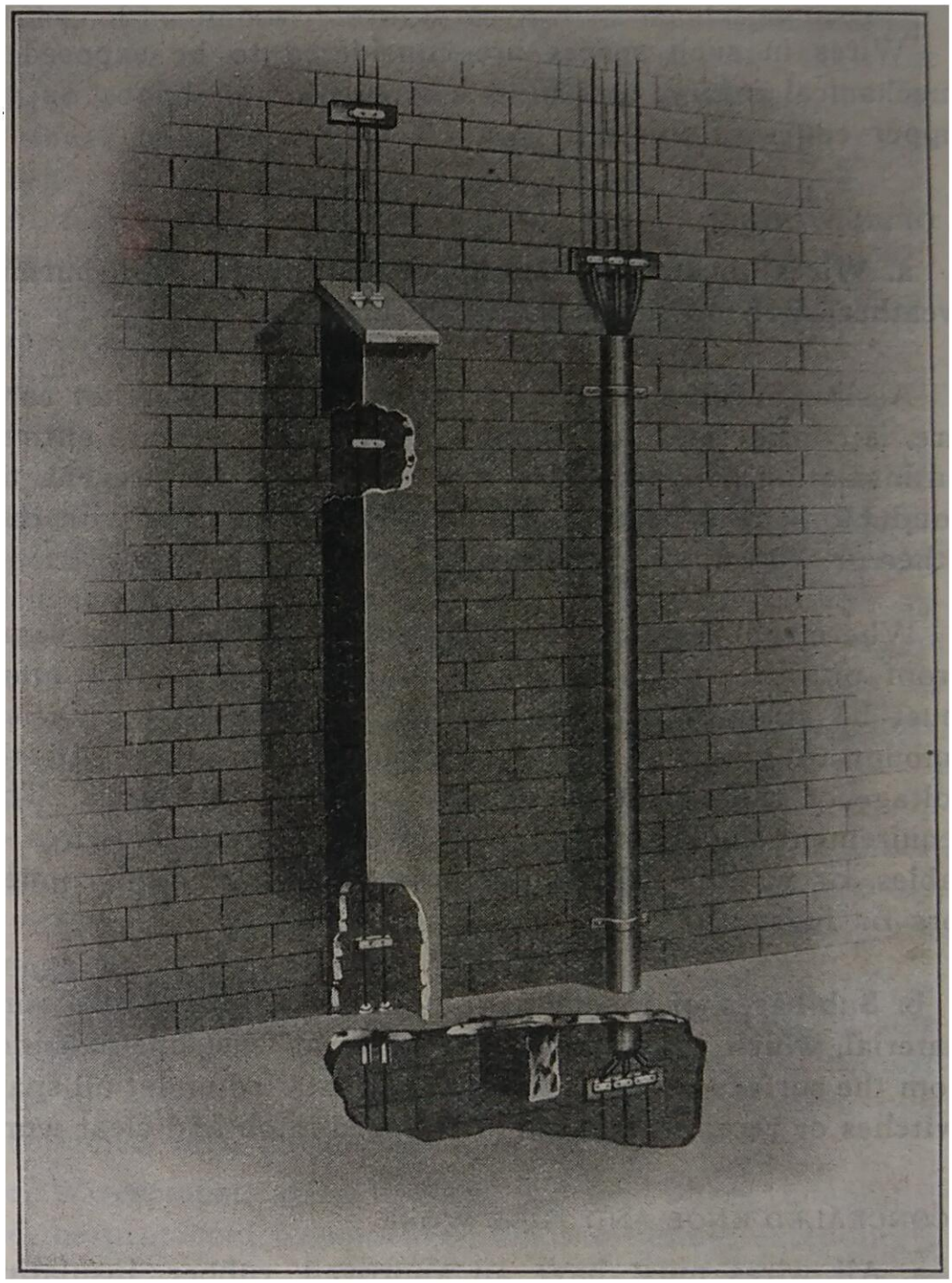

Fig. 24

to the wooden boxing; it is especially suitable for the protection of wires near belts, pulleys, etc (See Fig. 24.)

f. Wires, when run in roof spaces, must be treated as concealed, and when run in close proximity to water tanks or pipes, must be considered as exposed to moisture.

Wires in such spaces are considered to be exposed to mechanical injury, and must not be run on knobs on the upper edges of joists.

2. OPEN WIRING

a. Wires must have an approved rubber, slow-burning weatherproof, or slow-burning, insulation.

A slow-burning covering, that is, one that will not carry fire, is considered good enough where the wires are entirely on insulating supports. Its main object is to prevent the conductors from coming accidentally into contact with each other or with anything else.

Where rubber insulation is used and covered with a flame-proof or other braiding, such braiding or flame-proofing must be stripped back on all wires or cables, a sufficient amount to give the necessary insulation distances for the voltage of the circuit on which such wires are used. This requirement applies with equal force to joints in wires or cables, or where such conductors are sweated into connectors or lugs.

b. Sub-bases of incombustible, non-absorptive, insulating material, which will separate the wires at least one-half inch from the surface wired over, must be installed under all snap-switches or receptacles used in exposed knob and cleat work.

3. CONCEALED KNOB AND TUBE WORK

a. All wires must have an approved rubber insulating covering.

b. Wires must be rigidly supported at a distance of at least one inch from the surface wired over, and must be kept at least five inches apart.

They should preferably be run singly on separate timbers, or studding, and must be separated from contact with walls, floors, timbers, and partitions, through which they may pass, by tubes of incombustible, non-absorptive, insulating material, such as glass or porcelain. Wires passing through the cross timbers in plastered partitions must be protected by an additional tube extending at least four inches above the timber.

At distributing centres, outlets or switches, where space is limited, and the five-inch separation cannot be maintained, each wire must be separately encased in a continuous length of approved flexible tubing.

All wires in 2 inch stud partitions must be entirely enclosed in continuous flexible tubing.

c. When, in a concealed knob and tube system, it is impracticable to place the whole of a circuit on incombustible supports of glass or porcelain, that portion of the circuit which cannot be so supported must be installed with approved metal conduit, or approved armoured cable; except that if the difference of potential between the wires is not over 300 volts and if the wires are not exposed to moisture, they may be fished if separately encased in approved flexible tubing, extending in continuous lengths from porcelain support to porcelain support, from porcelain support to outlet, or from outlet to outlet, and wires must, except where taps are necessary, be in continuous lengths, without joints, throughout.

d. When using either conduit or armoured cable, in combination with concealed knob and tube work, the requirements for either conduit work or armoured cable work, must be complied with, as the case may be.

e. Wires must, at all outlets, except where conduit is used, be protected by approved flexible tubing, extending in continuous lengths from the last porcelain support to at least one inch beyond the outlet.

The proper finishing of wires at outlets is of great importance, more especially when used in conjunction with gas pipes.

From the last insulator to a point below the finish of ceiling, each wire must be separately enclosed in continuous approved flexible tubing, and some suitable method must be adopted to prevent this tubing from becoming detached from the wires. Taping them to the gas pipe is not approved, as it may be necessary to twist or screw out the gas pipe at some time; this might seriously injure the wires, or water might lodge between the tubing and the pipe, and lead to trouble.

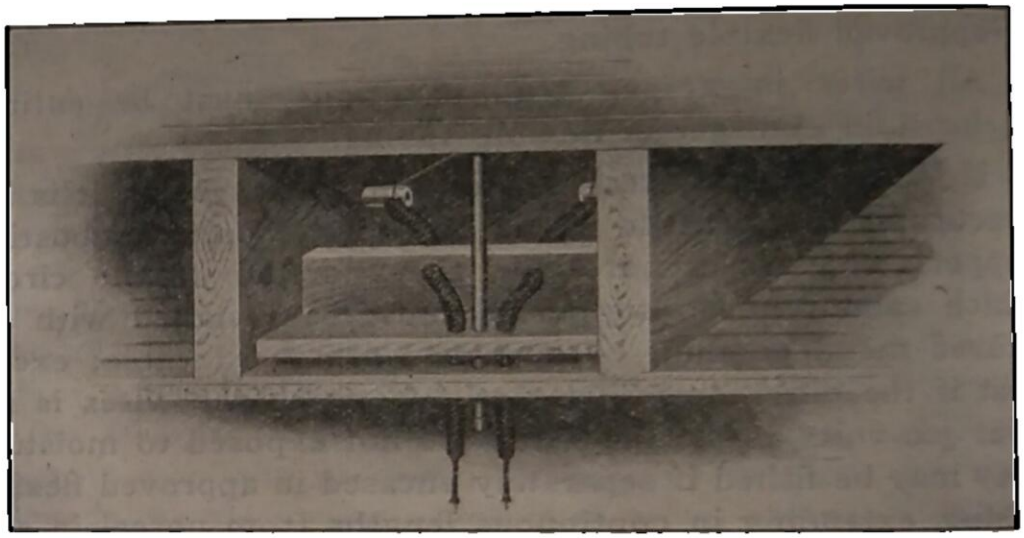

Fig. 25

The use of two outlet boards set on an angle of 90 degrees, as shown in Fig. 25, is regarded as reliable and satisfactory, and its use is advocated, unless an approved device is used which will effectually clamp the flexible tubing in place.

Where gas is used, the flexible tubing must be long enough to reach below the grounded portion of the insulating joint. (See Fig. 10.)

When the surface at any outlet is broken, it must be repaired, so as to leave no holes or open spaces at such outlet.

When it is impracticable to insert the outlet boards described above, as might be the case in knob and tube

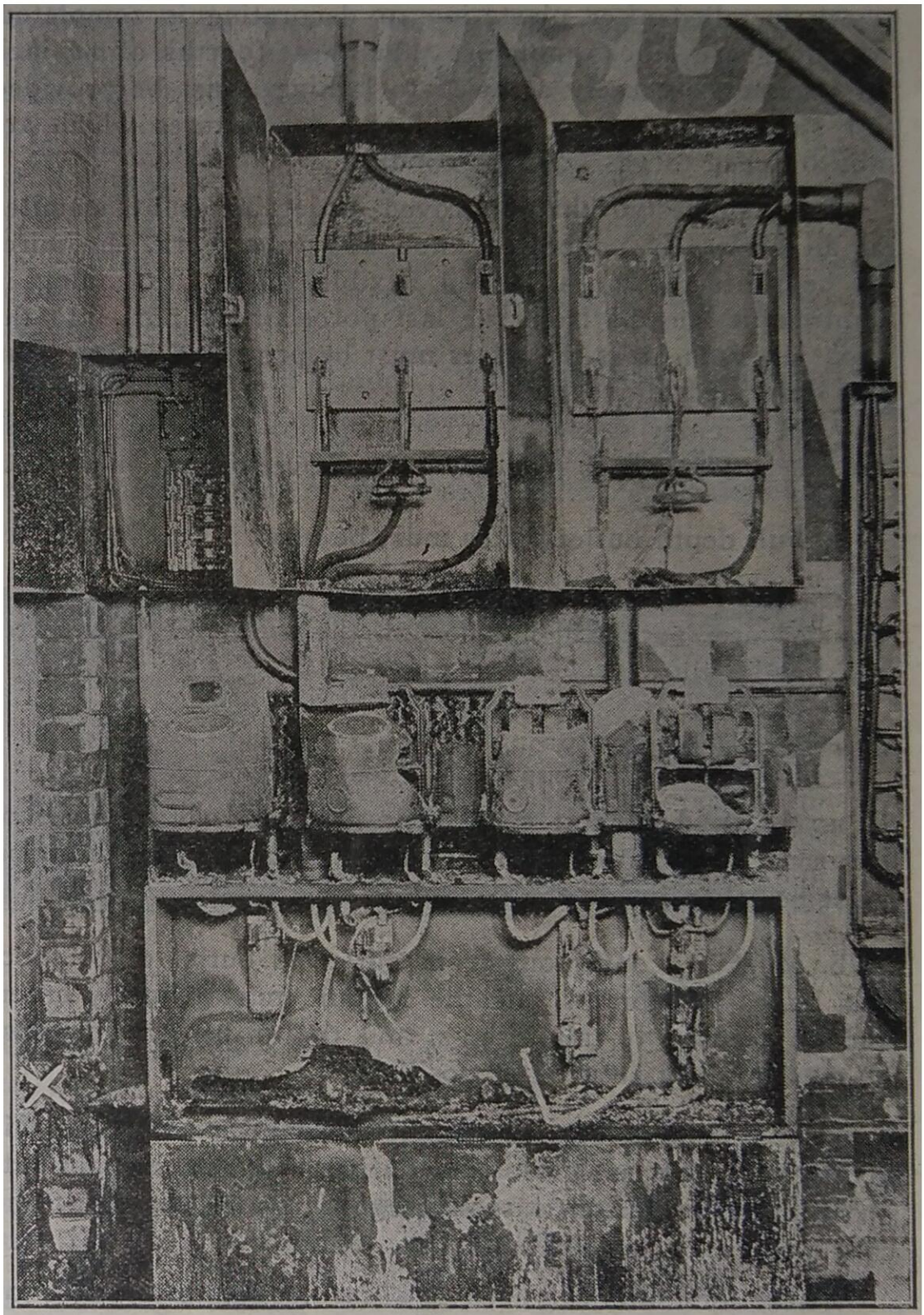

Fig. 26

Same accident as illustrated in Fig. 18. Damage inside building. Conduit pipe entered at point marked "x" at bottom left hand corner.

work installed after plastering or decorating is completed, wooden base blocks, not less than three-fourths of an inch in thickness, securely screwed to lathing, must be provided for switches, rosettes, etc., and also for fixtures which are not attached to gas pipes or conduit.

It is suggested that approved outlet boxes be installed at all outlets in concealed knob and tube work, the wires to be protected by approved flexible tubing, extending in continuous lengths from the last porcelain support into the box. In such cases the wires must be protected in the manner described above.

Where entering switch or outlet boxes flexible conduit must securely held in place by an approved fitting or method.

f. Full depth outlet boxes must be used.

Except in very narrow partitions or other similar locations where space will not permit, the use of shallow boxes will not be allowed.

4. INTERIOR CONDUIT WORK (Rigid and Flexible)

See Table "C," page 142

a. No rigid conduit tube having an internal diameter of less than five-eighths of an inch must be used. Measurement must be taken inside the conduit.

b. Must be continuous from outlet to outlet or to junction boxes or cabinets, and the conduit must properly enter, and be secured to, all fittings, and the entire system must be mechanically secured in position.

In the case of service connections and main runs, this involves running each conduit continuously into a main cut-out cabinet, or gutter surrounding the panel board, as the case may be. (See Fig. 19.)

Where lock nuts are used to secure conduits to outlet or other boxes, there must be one on each side of the wall of the box which will secure the conduit to the box unless the bushing is of hard metal and securely screwed to pipe.

c. Except in the case of flexible steel conduit of the built-in type, must be first installed as a complete conduit system, without the conductors.

The dimensions of the conduit and the arrangement of the conduit system as a whole must be such that the conductors may be drawn and withdrawn without injury.

d. Must be equipped at every outlet with an approved outlet box or plate.

At exposed ends of conduit (but not at fixture outlets), where wires pass from the conduit system without splice, joint or tap, an approved fitting having separately bushed holes for each conductor is considered the equivalent of a box. (See Fig 27.)

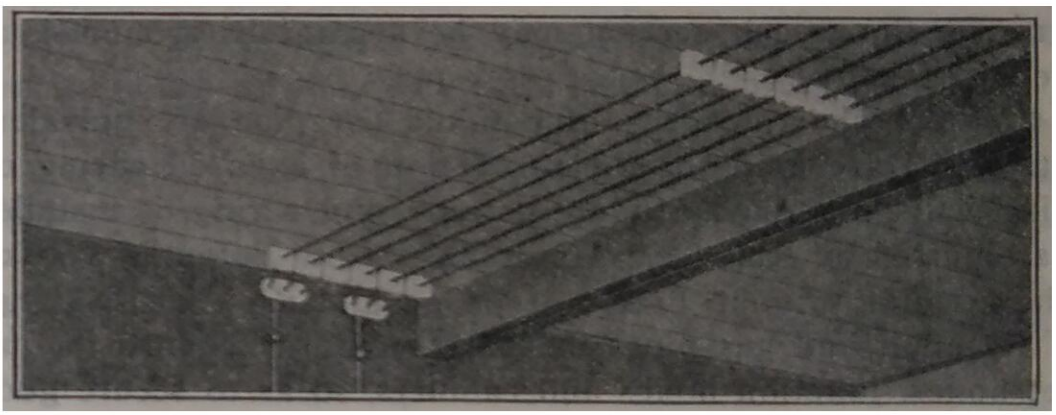

Fig. 27

Outlet plates must not be used where it is practicable to install outlet boxes.

The outlet box or plate must be so installed that it will be flush with the finished surface, and, if this surface be broken, it must be repaired so that no gaps or open spaces will show around the edge of the outlet box or plate.

In buildings already constructed, where the conditions are such that neither outlet box nor plate can be installed, these appliances may be omitted by special permission, provided that the conduit ends are bushed and secured.

It is suggested that outlet boxes and fittings having conductive coatings be used in order to ensure better electrical contact at all points throughout a conduit system.

e. Metal conduits, where they enter junction boxes, and at all outlets, etc., must be provided with approved bushings or fastening plates fitted so as to protect wires from abrasion, except when such protection is obtained by the use of approved nipples, properly fitted in boxes or devices.

f. Must have the metal of the conduit permanently and effectually grounded to water piping, gas piping or to a suitable ground plate. If connections be made to gas piping, they must be on the street side of the meter.

If the conduit system consists of several separate sections, the sections must be bonded to each other, and the system grounded; or each section may be separately grounded, as required above.

Where short lengths of conduit (or pipe of equivalent strength) are used for the protection of exposed wiring on side walls, and such conduit, or pipe, and wiring, is installed as required by Rule " e," " General," " Low Potential Work," the conduit or pipe need not be grounded. (See Fig. 24.)

Conduit and gas pipes must be securely fastened in outlet boxes, junction boxes and cabinets, so as to secure good electrical connection.

If conduit, couplings, outlet boxes, junction boxes, cabinets or fittings, having a protective coating of non-conducting material, such as enamel, be used, the coating must be thoroughly removed from threads of both couplings and conduit and also from surfaces of boxes, cabinets and fittings where the conduit or ground clamp is secured in order to obtain the requisite good connection.

g. Pull-in and junction boxes must always be installed in such a manner as to be accessible.

h. All elbows or bends must be so made that neither the conduit nor the lining of same will be injured.

The radius of the curve of the inner edge of any elbow must not be less than three and one-half inches on rigid conduit, nor less than one and one-half inches on flexible conduit or armouring. Conduit must not, for draw-in systems, have more than the equivalent of four quarter bends from outlet to outlet.

i. Wires used in conduit must have an approved rubber insulating covering, and must, within the conduit tubing, be without splices or taps.

Attention is here drawn to the fact that insulating rubber covering, for use in unlined conduits, must be double braided.

j. In all sizes larger than No. 12 B. and S. gauge, wires must be stranded.

Exception may be made in straight runs, if without any bends or offsets, where larger solid conductors could evidently be drawn and withdrawn without injury.

k. Conductors must not be drawn in until all mechanical work on a building has been, as far as possible, completed.

Conductors in vertical conduit risers must be supported within the conduit system in accordance with the following table:—

No. 14 to No. 0 every 100 feet.
No. 00 to No. 0000 every 80 feet.
No. 0000 to 350,000 c.m. every 60 feet.
350,000 c.m. to 500,000 c.m. every 50 feet.
500,000 c.m. to 750,000 c.m. every 40 feet.
750,000 c.m. every 35 feet.

The following methods of supporting cables are recommended:—

1. A turn of 90 degrees in the conduit system will constitute a satisfactory support.

2. Junction boxes, in which insulating supports of approved type must be installed and secured in a satisfactory

manner, may be inserted in the conduit system at the required intervals, so as to withstand the weight of the conductors attached thereto. Such boxes must be provided with proper covers.

3. Cables may be supported, in approved junction boxes, on two or more insulating supports so placed that the conductors will be deflected at an angle of not less than 90 degrees, and carried a distance of not less than twice the diameter of the cable from their vertical position. Cables so suspended may be additionally secured to these insulators by tie wires.

4. Other methods, if used, must be approved by the Inspection Department.

l. Must have the two or more wires of a circuit drawn in the same conduit.

Special permission to deviate from this rule may be given in the case of direct-current circuits if compliance with the rule be impracticable in some particular instance.

m. The same conduit must not contain more than twelve wires of the same system, except by special permission, and must never contain circuits of different systems.

5. MOULDING WORK

a. The use of wood moulding is not permitted.

b. For metal moulding, wires must have an approved rubber insulating covering, and must be in continuous lengths from outlet to outlet, or from fitting to fitting, no joints or taps being made in the moulding.

Where joints or taps are necessary, fittings, approved for the purpose, must be used. Under this rule, wires having a single braiding with a waterproof finish may be employed.

c. Metal mouldings must not be used for circuits carrying more than 1,320 watts.

d. The two or more wires of a circuit must be installed in the same moulding, as required for conduit. (See "Conduit," Rule "1," p. 74.)

e. Must be continuous from outlet to outlet, to junction boxes, or to approved fittings designed especially for use with metal mouldings, and must at all outlets be provided with approved terminal fittings which will protect the terminal insulation of conductors from abrasion, unless such protection is afforded by the construction of the boxes or fittings.

f. Where passing through a floor must be carried through an iron pipe extending from the ceiling below to a point five feet above the floor.

This will serve as an additional mechanical protection and exclude moisture often prevalent in such locations.

In residences, office buildings and similar locations, where appearance is an essential feature, and where the mechanical strength of the moulding itself is adequate, this ruling may be modified to require the protecting piping from the ceiling below to a point at least three inches above the flooring.

g. Backing must be secured in position by screws or bolts, the heads of which must be flush with the metal.

h. Must be grounded and bonded in the same manner as required for conduit.

The general rules under conduit must be observed, that is to say, the metal of the moulding and gas pipes must be securely fastened at outlet boxes, and where metal mouldings, couplings, etc., have protective coatings of non-conducting material, such coatings must be thoroughly removed from the surfaces of boxes, fittings, etc., at the point where a ground clamp is secured, and wherever else it may be necessary to make other good bonds or connections.

4. High Potential Work

(650 to 5,000 Volts)

a. Open wiring must never be employed unless it can be so located or protected as to be inaccessible to unauthorized persons, and only approved rubber-covered wires may be used.

Must always be in plain sight and never encased, unless specially required by the Inspection Department.

b. Where open wiring is permitted, all such rules in Section "B" as are applicable thereto, such as separation of wires from surface wired over and from each other, supporting, soldering, taping and general protection, must be observed.

This rule applies with equal force to wires run in conduits or tile ducts. Special care must be taken to prevent abrasion or destruction of the lead sheathing or the insulation on conductors. The grounding of metal conduit must be carried out with the greatest care, as it not only forms a protection from fire but is very necessary as a protection to life.

c. Except where open work is permitted, wiring must be in the form of multiple conductor, metal-sheathed cable, run in approved unlined metal conduit firmly secured in place.

The metal sheath, as well as the conduit, must be permanently and effectually grounded at intervals not exceeding 500 feet, and the rest of the conduit installation must conform to the rules for interior conduit, except that, at outlets, bushings must be used.

The insulation of the several conductors for high potential work, where leaving the metal sheath at outlets, must be thoroughly protected from moisture and mechanical injury. This may be accomplished by means of a pot-head or some equivalent device.

The conduit must be substantially bonded to the metal casings of all fittings and apparatus connected to the high-tension installation.

It is also permissible to run high potential cables, such as above, underground, or in the floors of fire-proof rooms in tile ducts. Such conductors must be lead sheathed unless the ducts can be kept permanently dry, in which case rubber insulation, as approved for conduit work, may be employed. Ducts must in all cases be so laid as to be properly drained.

d. All live parts of apparatus must be so placed or protected that they will be inaccessible to unauthorized persons.

With high voltages this rule must be very rigidly observed, and the term "inaccessible" in this instance must be interpreted in a much stricter sense than is required with lower voltages, i.e., that the touching of any live parts even deliberately, by unauthorized persons, must be rendered difficult; and it must not be possible, even for authorized persons, to touch any live parts *accidentally.*

So far as is practicable, high potentials must be confined to some particular section of a building to which unauthorized persons have no access; but where this is impossible, all live parts must be completely covered up or otherwise enclosed in such a manner that it will be impossible for any unauthorized person to come into dangerous proximity thereto.

III. WIRING UNDER SPECIAL CONDITIONS

The Rules under this heading must be observed in place of, or in addition to (as the case may be), the preceding Rules.

1. In Damp Places

a. In all damp places special attention must be paid to the matter of insulation in order to minimize danger of shock and fire.

As, in damp premises, all walls and other parts of a building are more or less conductive, and the atmosphere is moisture-laden, thereby rendering the electrical apparatus damp, precautions are necessary to ensure effective insulation, because electric shocks, under such circumstances, are of a more serious nature, and leakage is more liable to occur.

It is important that only insulators having a large leakage surface be used as, owing to the moisture on the insulators, their insulating property is greatly reduced. The use of the ordinary type of split knob is not approved, and only those types in which the supporting screw is entirely surrounded by porcelain throughout the length of the knob, thereby preventing possible contact of the wire with the screw, will be accepted.

In addition to the foregoing, it is also necessary to obviate all possibility of conductors coming into contact with walls, etc., as the effects of chemical action might be serious.

In the case of wires run horizontally, or nearly so, an excellent method of supporting wires in damp places or where they may be subjected to drip, is to attach their insulators to the underside of running boards or wire troughs, these troughs being coated with some form of moisture-proof paint; this not only affords increased mechanical protection to the wires, but protects them very largely from dripping water.

Glass or porcelain tie knobs are also approved, as well as petticoat insulators. The latter, however, must not be fixed at an angle of more than 45 degrees to the vertical, reckoned from their normal position.

b. All circuits in damp situations must, where practicable, be so arranged that all pressure can be cut off from a point outside the damp area.

In the case of chill rooms and like places, which are generally closed up and left unattended, the circuits in each separate room *must* be so controlled from a point outside, as close as possible to the doors of such rooms. All switches used for such control must be double-pole, all-porcelain, indicating, snap switches. Certain forms of flush switches entirely enclosed in tight cast-iron cases threaded to rigid conduit may be used, also knife switches in cast-iron boxes of such a design that they can be operated by handles without opening the box or exposing any live metal parts. All such devices must, however, be submitted and approved.

Defects on installations in damp places are liable to occur more frequently than in dry situations and it is, therefore, desirable that those sections of an installation should be arranged to be easily disconnected from the remainder.

c. Wires must have an approved rubber insulating covering unless lead-sheathed conductors be used.

d. Wiring on insulators or knobs and tubes must not be employed in concealed situations.

As, no matter what precautions be taken, the insulation of conductors is liable, in damp places, to suffer more rapid deterioration than in dry, it is undesirable to install wiring on insulators, etc., in concealed places.

e. Flexible cords must not be used unless served with an outer, braided, waterproof cover.

The insulation must be at least three sixty-fourths of an inch thick, and the braided covering must be either thoroughly saturated with a moisture-proof preservative compound, or be enclosed in an outer, braided moisture-proof, preservative covering over the whole.

f. Wooden and metal mouldings must not be used.

g. For potentials over 650 volts, all insulated conductors must have a lead covering.

As a general rule, higher potentials than 650 volts should not be employed at all in damp premises, but it might be necessary, for example, to carry a conductor of higher potential through a damp section to a place beyond, and it should, in such a case, be lead covered, as this affords the best protection against moisture.

h. All apparatus, fittings, fixtures, etc., must be of waterproof design, or enclosed in suitable waterproof covers or cabinets.

Fig. 28

Local circumstances will indicate the type of enclosure applicable.

i. Only "weatherproof" sockets must be used.

Unless attached to fixtures, they must be hung by separate *stranded,* rubber-covered wires, not smaller than No. 14 B. and S. gauge, which should preferably be twisted together when the pendant is over three feet long.

These wires must be soldered direct to the circuit wires, but supported independently of them. (See Fig 28.)

j. Switches and cut-outs, where their insulation would be seriously affected by moisture, vapor or dripping water, must be mounted on porcelain knobs or their equivalent.

Such knobs, etc., must furnish an air space of not less than one inch between the back of the switches or cut-outs and the surfaces to which they are attached.

k. All live parts of apparatus must be so placed or protected that they cannot be accidentally touched by unauthorized persons.

l. All exposed metal parts of apparatus, fittings, fixtures, etc., which do not carry current, including supports, covers, and the like must, for all potentials, be permanently and effectually grounded.

Grounding of exposed metal parts which do not carry current is necessary in damp places for all potentials, and not only for those above 300 volts, already required under ordinary conditions.

m. Flexible steel conduit must not be used in damp places unless the conductors contained therein are lead-sheathed, and all junction boxes and other outlet points can be filled or otherwise rendered water-tight.

* * * * * * * *

In laying out wiring installations in damp places, in addition to the foregoing rules, the following points must be observed:—

All joints in conductors must be carefully made and thoroughly finished with an approved compound, in order to prevent introduction of moisture to the conductors at such points.

Where possible, short weather-proof drip lights must be used, provided with either porcelain, or hard-rubber, pig-tail sockets, as illustrated in Fig. 28.

Rubber rings should be run on all sockets around lamp bases to prevent the introduction of moisture to the sockets, and the sockets should be provided with suitable lamp guards.

In locating switch and cut-out cabinets, where practicable, they should be placed outside the damp area, such as in an adjoining room or passageway.

Where conduit work may be permitted in certain sections of damp places, where it is difficult to otherwise protect the wires from mechanical injury, the conduit must be well threaded and leaded, and all lights must be in approved vapor-proof globes of such construction that moisture cannot enter the globes or the points at which they are connected to the conduit system.

All woodwork used in the construction of wire troughs, guard strips, cabinets or boxing-in for wires, must be well painted with moisture-proof paint to prevent, as far as possible, the absorption of moisture.

While Rule "d" does not permit the use of wires, in concealed places, on knobs and tubes, it is not intended to prevent the provision of sufficient mechanical protection, e.g., wooden boxing, so long as the wires may be readily got at by the removal of such protection.

2. In Premises Containing Corrosive Liquids or Vapors

a. In premises containing corrosive liquids or vapors, special care must be taken to protect all materials used in installations against destructive chemical action.

All apparatus, fittings, fixtures, etc., must either be in themselves capable of resisting corrosive action, or they must be efficiently protected against chemical injury by means of a suitable impregnation or coating; or they must be completely enclosed in vapor-tight, non-corrosive covers.

Bare conductors must either be made of some metal which will not suffer corrosion under the conditions prevalent in any particular case, or they must be galvanized, varnished, or otherwise efficiently protected.

Insulated conductors must either have an insulation which will not corrode, or an extra covering or coating of some suitable material must be provided in addition to the insulation.

Conductors for portable apparatus, and twisted conductors for cord pendants, etc., must be protected by a cover which is both water-tight and non-corrosive.

No hard and fast rules can be laid down as to what are the most suitable materials to employ in any premises where corrosive liquids or vapors are present, the requirements depending on the particular circumstances of each case.

Copper and lead are both readily attacked by nitric acid, although hydrochloric and sulphuric acids have but little effect upon them. Aluminum is practically unaffected by nitric acid, while hydrochloric acid has some corrosive action upon it. Zinc, unless quite pure, is readily attacked by sulphuric and hydrochloric acids. These examples will serve to show that it would be impossible to formulate general rules which would cover all conditions.

In some cases, it may be necessary to take due precautions in the choice of materials employed for supporting any electrical apparatus, wires, etc. For example, iron screws might be subject to a very rapid corrosion, thus rendering them unreliable as a means of support, whereas brass screws, under the same conditions, might be quite satisfactory.

It may here be pointed out that, owing to the electrolytic action of direct current in the presence of acidulated moisture, the use of alternating current, if practicable, is to be preferred under the conditions with which this subsection deals.

b. The question of insulation must be also given very careful consideration, as, where corrosive liquids and vapors are present, leakage is likely to take place to a greater extent even than in ordinary damp places.

Wires must be supported on insulators which will provide a separation from the surface wired over of at least one and one-half inches; this distance may be required to be increased considerably, especially where the potential exceeds 300 volts. In all instances, petticoat insulators would be preferable to those of any other form.

Increased spacing is desirable between conductors and between all live parts at different potentials, and may be essential, in order to reduce leakage to a reasonable degree.

c. Potentials exceeding 650 volts must not be employed for either power or lighting.

In the premises to which these rules refer, even with the greatest precautions, corrosion is liable to occur, thus greatly increasing the risk of shock and fire, especially with high voltages.

d. Wooden or metal mouldings must not be employed.

3. In Premises Containing Explosive Materials

a. In premises containing explosive material all sparking or arcing must be entirely obviated or must be so isolated that risk of explosion from this cause will be reduced to a minimum.

The rules under this section refer chiefly to such materials as give off explosive vapors, such as gasoline, etc., in the presence of which it is evident that any sparking or arcing which might occur would be highly dangerous. As such gases find their way into the inside even of so-called gas-tight cases, no apparatus in the operation of which sparking or arcing is liable to occur must be placed in premises where such gases are present, as an explosion might take place inside, destroying the case and igniting the gas outside. Such gas-tight cases may, however, be employed in premises where only such materials as coal or flour dust, etc., are present in the atmosphere.

b. Except as provided for under Rule "g," "Installations in Damp Places," potentials exceeding 300 volts must not be employed.

c. Only armoured cable or steel conduit systems may be employed.

Open wiring, either bare or insulated, is easily damaged, and, therefore, unsuitable. Bare conductors are manifestly inadmissible in such premises, as also is metal moulding, as this latter cannot be made gas-tight; if, on account of any defects, sparking should occur, a serious explosion might take place. Where conduit wiring is used, only those forms of vapor-proof globes must be used which become part of the conduit system, and together with the conduit system, must be entirely gas-tight throughout.

If the draw-in system of conduit be used, it must be what is known as "rigid metal." If it is desired to use flexible steel conduit, it must not be of the draw-in type, but of the style known to the trade as "B.X. Cable," being a multiple conductor contained in an impregnated braiding, the whole being closely wound with steel armouring.

The same precautions in attaching such cables to fittings must be observed as are called for in the foregoing requirement for rigid conduit, that is to say, effective means must be adopted to prevent the entry of fumes or gases at junction or outlet points.

d. All commutating and slip-ring motors must be totally enclosed if highly explosive vapors be present.

Short-circuited rotor motors need not be so enclosed.

Asynchronous motors, with wound rotors, need only have the slip rings enclosed.

e. Motor-starting devices, with movable contacts, must be enclosed in gas-tight cases.

f. Resistances must be either placed outside the danger zone or enclosed in gas-tight cases thoroughly ventilated to the outside air.

g. Only incandescent lamps must be used. Arc, Nernst, or similar lamps must not be employed.

3a. Garages.

For the purposes of the following rules a garage is considered as that building or portion of a building in which one or more self-propelled vehicles carrying volatile inflammable liquid for fuel or power are kept for use, sale, storage, rental, repair, exhibition or demonstration purposes; and all that portion of a building that is on or below the floor or floors on which such vehicles are kept which is not separated therefrom by tight unpierced fire walls and fire-resisting floors.

In addition to the general requirements of the rules the following shall apply.—

1. In garages used for more than two vehicles, as above, all conductors except those required for pendant lamps or portable connections must be installed in metal conduits or armcured cable, except that metal moulding may be used only in offices and show-rooms. Metal conduit, armoured cable or metal moulding must be so installed that all outlet and junction boxes shall be located at least four feet above the floor. In garages used for one or two vehicles, as above, conduit or armcured cable construction is not required.

2. Flexible cord for pendant lights must be approved reinforced cord.

3. Flexible cords for portable lamps, motors or other apparatus must be approved cord designed for rough usage. The portable cord must carry the male end of an approved pin plug connector or equivalent, the female end being of such design or so hung that the connector will break apart readily at any position of the cable. The connector must be kept at least four feet above the floor.

4. Flexible cord for charging must be of approved theatre stage type, this cable carrying parts of approved connectors of at least fifty amperes capacity. The connectors must be of such design or so hung that at least one will break apart readily at any position of the cable. Current-carrying parts of the connectors must be shielded to prevent accidental contact. The fixed, or wall connector, must be kept at least four feet above the floor, and if not located on switchboard or charging panel, must be protected against accidental contact.

5. Cut-outs, switches and receptacles must be placed at least four feet above the floor, except as provided in rule "7" below.

6. All portable lights must be equipped with keyless sockets of moulded composition or metal-sheathed porcelain type. These sockets must be equipped with handle, hook and substantial guard.

7. Switchboards and charging panels, at or upon which are mounted devices which in operation may produce a spark, must be located in a room or enclosure provided for the purpose unless all such spark producing devices are at least four feet above the floor or surrounded by vapor proof enclosures.

8. Motors or dynamos, not actually a part of a vehicle, if not located at least four feet above the floor must be of the fully enclosed type. Motors located four feet or more above the floor, if not of the fully enclosed type, must be provided with wire screen of not less than No. 14 mesh over openings at commutator end.

4. In Theatres and Moving Picture Establishments

a. Electrical apparatus and equipment, situated in any part to which the public is admitted, must only be accessible to authorized persons.

To attain this object, all apparatus, etc., must be protected by a cover, or placed in a cabinet, and so locked or secured that it cannot be touched or operated by unauthorized persons; or it must be remote from access.

b. 1. Where supply may be obtained from two entirely separate sources, two separate and distinct services must be installed, one service to be of sufficient capacity to supply current for the entire equipment of the theatre, while the other service must be of sufficient capacity to supply current for all emergency lights.

2. Where supply cannot be obtained from two separate sources, the feed for emergency lights must be taken from a point on the street side of the main service fuses.

3. Where the source of supply is an isolated plant within the same building, an auxiliary service, of at least sufficient capacity to supply all emergency lights, must be obtained from some outside source; or a suitable storage battery within the premises will be considered the equivalent of such service.

By "emergency lights" is meant exit lights and all lights in lobbies, stairways, corridors, and other portions of a theatre to which the public has access, which are normally kept lighted during the performance.

c. All lamps and luminous radiators on the stage side of the curtain, including those used in dressing-rooms, must be protected by suitable guards.

STAGE

d. All permanent wiring on the stage side of the proscenium wall, including that in dressing-rooms, except as hereinafter provided, must be in approved conduit, or armoured cable must be used.

SWITCHBOARDS

e. Where accessible from the stage level, must be protected by a suitable guard rail to prevent accidental contact with live parts on the board.

FOOTLIGHTS

f. 1. Must be wired in approved conduit, or armoured cable must be used; each lamp receptacle must be enclosed within an approved outlet box, or the lamp receptacles may be mounted in an iron or steel box.

The metal used for such boxes must be of a thickness not less than No. 20 U. S. sheet metal gauge; it must be treated to prevent oxidation and the boxes must be so constructed as to enclose all the wires. Wires must be soldered to the lugs of receptacles.

2. They must also be so wired that no set of lamps requiring more than 1,320 watts nor more than 24 receptacles shall be dependent upon one cut-out.

BORDERS AND PROSCENIUM SIDE-LIGHTS

g. 1. Must be constructed of steel of a thickness not less than No. 20 U. S. sheet metal gauge, treated to prevent oxidation, suitably stayed and supported and so designed that the flanges of reflectors will protect the lamps.

2. Must be so wired that no set of lamps requiring more than 1,320 watts nor more than 24 receptacles shall be dependent upon one cut-out.

3. Must be wired in approved conduit, or armoured cable must be used; each lamp receptacle must be enclosed within an approved outlet box; or the lamp receptacles may be mounted in an iron or steel box.

The metal of such boxes must be of a thickness not less than No. 20 U. S. sheet metal gauge and treated to prevent oxidation, and they must be so constructed as to enclose all wires, which latter must be soldered to the lugs of receptacles.

4. Must be provided with suitable guards to prevent scenery or other combustible material from coming in contact with the lamps.

5. Cables for borders must be of approved type and suitably supported; conduit construction must be used from the switchboard to the point where cables must be flexible to permit of the raising and lowering of the borders.

6. For the wiring of the border proper, wire having approved slow-burning insulation must be used.

7. Borders must be suitably suspended, and if a wire rope be used, at least one strain insulator must be inserted at the border.

STAGE AND GALLERY POCKETS

h. 1. Must be of approved type, controlled from the switchboard, each receptacle must be of not less than 35 ampere rating for arc lamps nor 15 ampere for incandescent lamps, and be wired for its full rating. Arc pockets must be

wired with conductors not smaller than No. 6 B. & S. gauge and incandescent pockets with not less than those of No. 12 B. & S. gauge.

2. Plugs for arc and incandescent pockets must not be interchangeable.

SCENE DOCKS

i. If lamps be placed in Scene Docks, they must be so located and installed that they will not be liable to suffer mechanical injury.

CURTAIN MOTORS

j. Must be of iron-clad type.

CONTROL OF STAGE FLUES

k. In cases where dampers are released by an electric device, the electric circuit operating it must be normally closed.

The magnet operating the damper must be wound to take the full voltage of the circuit to which it is connected, using no resistance device, and must not heat more than the normal for apparatus of similar construction; it must be located in the loft above the scenery and be enclosed in a suitable iron box with a tight self-closing door.

Such dampers must be controlled by at least two standard single-pole switches mounted within approved iron boxes provided with self-closing doors, without lock or latch, and located, one at the electrician's station, and others as may be designated by the Inspection Department.

DRESSING ROOMS

l. All pendant lights must be equipped with approved reinforced cord, armoured cable, or steel armoured flexible cord.

PORTABLE EQUIPMENT

m. Arc lamps used for stage effects must conform to the following requirements:—

1. Must be constructed entirely of metal except where the use of insulating material is necessary.

2. Must be substantially constructed, and so designed as to provide for proper ventilation and prevent sparks from being emitted from the lamps when they are in operation; mica must be used for frame insulation.

3. The front opening must be provided with a self-closing hinged door-frame, in which wire gauze or glass must be inserted, except in the case of lens lamps, where the front may be stationary, and a solid door must be provided on the back or side.

4. Must be so constructed that neither carbons nor live parts will be brought into contact with the metal of the hood during operation, and arc lamps, frames and standards must be so installed and protected as to prevent them from becoming grounded.

5. The switch on the standard must be so constructed that accidental contact with any live portion thereof will be impossible.

6. All standard connections in the lamp and at the switch and rheostat must be provided with approved lugs.

7. Rheostats must be plainly marked with their rating in volts and amperes and, if mounted on the standard, must be raised to a height of at least three inches above the floor. Resistances must be enclosed in a substantial and properly ventilated metal case affording a clearance of at least one inch between the case and the resistance element.

8. A competent operator must be in charge of each arc lamp, except that one operator may have charge of two lamps when they are not more than ten feet apart, and are so located that he can properly watch and care for both lamps.

BUNCHES

n. Must be substantially constructed of metal and must not contain any exposed wiring.

The cable feeding them must be bushed in an approved manner where passing through the metal, and must be properly secured to prevent any mechanical strain from coming on the connection.

STRIPS

o. 1. Must be constructed of steel of a thickness not less than No. 20 U. S. sheet metal gauge, treated to prevent oxidation, suitably stayed and supported, and so designed that the flanges will protect the lamps.

2. Cable must be bushed in a suitable manner where passing through metal, and must be properly secured to prevent undue mechanical strain from coming on the connections.

3. Must be wired in approved conduit, or armoured cable must be used. Each lamp receptacle must be enclosed within an approved outlet box, or the lamp receptacles may be mounted in an iron or steel box.

The metal of such boxes must be of a thickness not less than No. 20 U. S. sheet metal gauge, and treated to prevent oxidation, and boxes must be so constructed as to enclose all wires, which latter must be soldered to the lugs of receptacles.

PORTABLE PLUGGING BOXES

p. 1. Must be constructed so that no current-carrying part will be exposed, and each receptacle must be protected by approved fuses, mounted on slate or marble bases and enclosed in a fire-proof cabinet equipped with self-closing doors.

2. Each receptacle must be constructed to carry thirty amperes without undue heating, the bus-bars must have a carrying capacity equivalent to the current required for the total number of receptacles, and approved lugs must be provided for the connection of the master cable.

PIN PLUG CONNECTORS

q. Must be of an approved type, so installed that the "female" part of the plug will be on the live end of the cable and must be so constructed that tension on the cable will not cause undue mechanical strain on the connection.

PORTABLE CONDUCTORS

r. Flexible conductors run from receptacles to arc lamps, bunches or other portable equipments, must be approved stage cable; except that for the purpose of feeding a stand lamp under conditions where conductors are not liable to suffer severe mechanical injury, an approved reinforced cord may be used, provided that the fuse in the cut-out employed to protect the lamp is not rated for more than six amperes.

LIGHTS ON SCENERY

s. Where brackets are used they must be wired entirely on the inside, the fixture stem must come through to the back of the scenery and the end of the stem must be properly bushed.

STRING OR FESTOONED LIGHTS

t. 1. Wiring of these must be of an approved method; joints must be properly made, soldered and taped, and staggered where practicable.

2. Where lamps are used in lanterns or similar devices, approved guards must be employed.

SPECIAL ELECTRICAL EFFECTS

u. Where devices are used for producing special effects, such as lightning, waterfalls, etc., the apparatus must be so constructed and located that flames, sparks, etc., resulting from its operation cannot come in contact with combustible material.

To obtain special effects, potentials exceeding 300 volts are sometimes necessary, and, where employed, must be under the direct charge of a trained attendant while pressure is on, and all temporary conductors, apparatus, etc., used in connection therewith, must be removed as soon as they are done with.

AUDITORIUM

v. 1. All wiring must be installed in approved conduit or metal moulding; or armoured cable must be used.

2. Exit lights must not have more than one set of fuses between them and the service fuses.

3. Exit lights and all lights in halls, corridors, or any other part of the building used by an audience, except the general auditorium lighting, must be fed independently of the stage lighting and must be controlled only from the lobby or other convenient place in front of the house. All fuses must be enclosed in approved cabinets.

MOVING PICTURE EQUIPMENTS

w. 1. Arc lamps used as a part of a moving picture machine:—Must be constructed, so far as is practicable, similarly to arc lamps of theatres, and conductors must have a current-carrying capacity not less than that of No. 6 B. & S. gauge copper wire.

2. Rheostats: Must conform to rheostat requirements for theatre arcs, and must be kept outside of the cabinet.

3. Top and Bottom Reels: Must be enclosed in steel boxes or magazines, each with an approved opening, either at the bottom or the top, so arranged as not to permit the entrance of flame to the magazine.

No solder is to be used in the construction of these magazines. The front side of each magazine must consist of a spring-hinged door, swinging horizontally, and provided with a substantial latch.

4. Automatic Shutter: Must be provided and be so constructed as to shield the film from the beam of light whenever the film is not running at operating speed. The shutter must be permanently attached to the gate frame.

5. Extra Films: Must be kept in individual metal boxes equipped with tight-fitting covers.

6. Machine Operation: If practicable, must be operated by hand.

The only exception, so far, to the observance of this rule, for which permission is granted is the "Kinemacolour Machine," which is specially designed for motor drive, as hand operation is not practicable.

MACHINE ENCLOSURE

7. The machine must be placed in an enclosure or house made of suitable fire-proof material. The enclosure must be properly ventilated, properly lighted and large enough for the operator to walk freely on either side of or at the back of the machine.

All openings into this booth must be so arranged as to be entirely closed by doors or shutters constructed of the same, or equally good, fire-resisting materials as the booth itself. Doors or covers must be arranged so as to be held normally closed by spring hinges or equivalent devices.

Cut-outs and switches, if placed inside the booth, must be so located or of such design that the danger of communicating fire will be, as far as possible, eliminated.

8. Reels containing Films under Examination or in Process of Re-Winding: Must be enclosed in magazines or approved metal boxes similar to those required for films in operation, and not more than two feet of film must be exposed in the booth.

x. "Moving Picture" machines, with inflammable films, must not be operated in any premises except those in which the installation complies with the foregoing.

This rule will not prevent the use of moving picture machines with inflammable films in places other than those classed as "theatres," provided that special permission be obtained from the Inspection Department. Such permission will only be granted when every reasonable safeguard has been observed, and in no case unless the machine be enclosed in a cabinet which, in effect, complies with all the foregoing requirements.

5. Outline and Sign Lighting

The title "Outline and Sign Lighting" will be considered as covering any wiring run to or on the outside of any building or structure to supply current outside of the said building, etc., to any fixture or device which is not in use solely for illuminating purposes, and for which fixtures, etc., separate circuits must be provided.

a. Must be connected only to low potential systems, and must be controlled by a switch which completely cuts off the supply.

b. Open or conduit work may be used, but moulding will not be permitted.

c. All wires must be double-braided, rubber-covered, and if open wiring be employed, a minimum distance of one inch from the surface wired over must be maintained.

d. Where flexible tubing is required, it must be kept at least one-half inch from the surface wired over and the ends must be sealed and painted with moisture repellant.

e. Where armoured cable is used, the conductors must be protected from moisture by a lead sheath between the armour and the insulation.

f. Cut-outs, switches, time-switches, flashers and similar appliances, if located inside the building, must comply with the rules governing such devices; if located outside the building they must be enclosed in a steel or cast-iron water-tight box.

If a steel box be used, the minimum thickness of the steel must be 0.125 of an inch (No. 11 U. S. sheet metal gauge). Boxes must be so constructed that when the switch operates the blade will clear the door by at least one inch.

g. Every circuit for outline or sign lighting must be distinct from all other circuits in an installation.

As the working conditions of sign and outline lighting are different from those of ordinary lighting installations, these two classes of lighting should be kept quite distinct.

All such circuits should branch off from the main distribution board, or, in the case of large installations, they may be taken from the nearest sub-distribution board, provided that the cables leading thereto are of ample size. In no case should such circuits be utilized to supply minor sub-circuits (for example, two or three lamps) for use inside the building. There would be no objection, however, to having two or three signs supplied with current from the same mains. Having regard to the situation of any outline or sign-lighting (i.e., whether inside or outside buildings), such rules as are applicable must be complied with.

It is obvious that sign lights must not be so placed as to admit the possibility of overhead conductors, such as feeders, trolley wires, etc., coming into contact with them. Additional insulation over the conductors, such as porcelain tubes, or other devices, will not be allowed as an alternative.

h. Circuits must be so arranged that not more than 1,320 watts will be finally dependent upon a single cut-out, nor must more than 66 sockets or receptacles be connected to a single circuit.

In any circuit having a common return for several sets of lamps, such return must be of sufficient size, in accordance with table "A," "Conductors," to carry the current for the maximum number of lamps which it is possible to have on at one time.

Where the current supplying lamps in signs is derived from a low voltage transformer and where the potential does not exceed 25 volts, the lamps may be wired in multiple series but no circuit must be subdivided in such a way as to require more than 150 receptacles connected to any one branch circuit.

i. Sockets and receptacles must be of the keyless porcelain type and wires must be soldered to their lugs.

j. Signs must be constructed entirely of metal or other approved incombustible material, except that wood may be used on the outside as decoration if kept at least two inches from lamp receptacles.

Sheet metal must not be less than No. 28 U. S. sheet metal gauge.

All metal must be galvanized, enamelled or treated with at least three coats of anti-corrosive paint, or otherwise protected in an approved manner against corrosion..

Signs must be so constructed as to secure ample strength and rigidity and must be practically weather-proof. They must also have the maker's name or trademark permanently attached to the exterior. All terminals and wiring other than the supply leads must be enclosed, except that open work will be permitted for signs on roofs or open ground where not subject to mechanical injury, provided that the wiring is in accordance with the appropriate portion or portions of Section "B."

k. Cut-outs, transformers unless of weather-proof type, flashers and other similar devices on or within the sign structure, must be in a separate, completely enclosed, accessible and weather-proof compartment, or in a substantial metal weather-proof box or cabinet, the thickness of the walls of which must not be less than that of the metal of the sign itself.

Every compartment must have suitable provision for drainage through one or more holes, each not less than one-quarter of an inch in diameter.

l. Receptacles must be so designed as to afford permanent and reliable means to prevent possible turning, and their terminals must be at least one-half inch from other terminals and from the metal of the sign; except that, where open work is permitted, this separation must be one inch. Miniature receptacles will not be approved for use in outdoor signs.

In those parts of circuits where wires are connected to approved receptacles which hold them at least one inch from the surface wired over, and which are placed not over one foot apart, such receptacles will be considered to afford the necessary support and spacing for the wires. Between receptacles more than one foot, but less than two feet, apart, an additional incombustible, non-absorptive insulator, maintaining a separation and spacing equivalent to that provided by the receptacles, must be used.

m. Leads from signs must either pass through the walls of signs in approved metal conduit, or armoured cable must be used; the leads must be neatly cabled and pass through one or more approved incombustible, non-absorptive bushings.

6. Temporary Work

a. Under this heading the rules for permanent work need only be so far observed as to effectually guard against shock and fire.

Temporary installations may be authorized, in writing, by the Inspection Department. Each case will be treated on its merits and the duration of the period over which the permit shall extend will be regulated accordingly.

Temporary permits may be renewed for a further period at the discretion of the Inspection Department.

SECTION C

MISCELLANEOUS

For work in this section the rules in other portions of this book, in so far as they are applicable, must be observed, unless they are rendered superfluous or nugatory by the requirements here set forth.

I. LIGHTING AND POWER FROM RAILWAY WIRES

Will not be permitted in the same circuit with trolley wires with a ground return, except in electric railway cars, electric car houses, power houses, passenger and freight stations connected with the operation of electric railways.

II. SERIES LAMPS

a. No multiple-series or series-multiple system of lighting will be approved.

b. Series lamps must not, under any circumstances, be attached to gas fixtures.

III. CONSTANT CURRENT SYSTEMS

As series arc lighting systems are seldom used for inside illumination at the present day, and those already installed are being gradually replaced by multiple systems, it is not deemed advisable or necessary to draft special rules governing this class of work. If, however, circumstances should warrant it, and no other system be available, the Commission may grant special permission for the use of such a system inside a building, provided that the wiring and apparatus be installed in such a way that danger to life or property is, as far as practicable, eliminated.

The greatest field for a constant current system is street lighting; the disadvantages of such a system for inside use are due to the fact that, generally, extra high voltages are used with an increased risk of breakdown of insulation, resulting in danger to persons and risk of fire, and also to the fact that an interruption of current causes loss of light over a considerable area.

IV. ELECTRIC GAS LIGHTING

Electric gas lighting, unless it be the frictional system, must not be used on the same fixtures with electric light.

V. SIGNALLING SYSTEMS

Governing wiring for telephone, telegraph (except wireless telegraph apparatus), district messenger and call-bell circuits, fire and burglar alarms, and all similar systems which are hazardous only because of their liability to become crossed with electric light, heat or power circuits.

a. Outside wires must be run in underground ducts or strung on poles, and kept off the roofs of buildings, unless permission to the contrary be given, and must not be placed on the same cross-arm with electric light or power wires. They must not occupy the same duct, manhole or hand-hole of conduit systems with electric light or power wires.

Single manholes, or hand-holes separated into sections by means of partitions of brick or tile will be considered as conforming with the above rule.

The liability of accidental crossing of overhead signalling circuits with electric light and power circuits may be guarded against to a considerable extent by endeavoring to keep the two classes of circuits on different sides of the same street.

***When the entire circuit from Central Station to building** is run in underground conduits, Rules "b" to "m" inclusive do not apply.*

b. When outside wires are run on the same pole with electric light or power wires, the distance between the two inside pins of each cross-arm must not be less than twenty-four inches.

Signalling wires, being smaller and more liable to break and fall, should be generally placed on the lower cross-arms

When the wires are carried in approved cables, the next three rules (c, d and e), do not apply.

c. Where wires are attached to the outside walls of buildings they must have an approved rubber insulating covering, and on frame buildings or frame portions of other buildings must be supported on glass or porcelain insulators, or knobs.

d. The wires from the last outside support to the cut-outs or protectors must be of copper and must have an approved rubber insulation; drip loops must be formed immediately outside the building at the point of entrance of the wires.

e. Wires must enter buildings through approved incombustible, non-absorptive, insulating bushings sloping upward from the outside.

Installations where the current-carrying parts of the apparatus installed are capable of carrying indefinitely a current of ten amperes:—

f. An all-metallic circuit must be provided, except in telegraph systems.

g. At the entrance of wires to buildings, approved single pole cut-outs, designed for 251-650 volts potential and containing fuses rated at not over ten amperes capacity, must be provided for each wire.

These cut-outs must not be placed in the immediate vicinity of easily ignitible stuff, or where exposed to inflammable gases or dust, or to flyings of combustible material.

h. The wires inside a building must be of copper of not less than No. 16 B. and S. gauge, and must have the same insulation and be supported in the same manner as would be required for an installation of electric light or power wiring for 10-650 volts potential.

i. The instruments must be mounted on bases constructed of incombustible, non-absorptive, insulating material. Holes for the supporting screws must be so located or counter-sunk

that there will be at least one-half inch space, measured over the surface, between the head of the screw and the nearest live metal part.

Installations where the current-carrying parts of the apparatus installed are not capable of carrying indefinitely a current of ten amperes:—

j. Must be provided with an approved protective device located as near as possible to the entrance of wires to building.

The protector must not be placed in the immediate vicinity of easily ignitible stuff, or where exposed to inflammable gases or dust, or flyings of combustible materials.

k. Wires from entrance to building, to the protector, must be so supported on porcelain insulators, that they will come in contact with nothing except their proper supports.

l. The ground wire of the protective device must be run in accordance with the following requirements:—

1. Must be of copper and not smaller than No. 18 B. and S. gauge.

2. Must have an insulating covering approved for voltages from 0 to 650, except that the preservative compound may be omitted.

3. Must run in as straight a line as possible to a good permanent ground.

If attachment be made to a gas pipe, the connection in all cases must be made between the meter and the street main and must be made as near as possible to the earth.

This may be obtained by connection to a water or gas pipe connected to the street mains or to a ground rod or pipe driven in permanently damp earth. When connections are made to pipes, preference must be given to water pipes.

When the ground wire is to be attached to a water or gas pipe, it may be connected by means of an approved ground clamp fastened to a thoroughly clean portion of the pipe; or the pipe must be thoroughly cleaned and tinned

with rosin flux solder, the ground wire being then wrapped tightly around the pipe and properly soldered to it.

If the ground wire be attached to a ground rod driven into the ground, it must be soldered to the rod in a similar manner.

Steam or hot water pipes must not be used for a protector ground.

m. The protector, to be approved, must comply with the following requirements:—

For Instrument Circuits of Telegraph Systems:—

1. An approved single pole cut-out, in each wire, designed for 2,000 volts potential, and containing fuses rated at not over one ampere.

When the main line cut-outs are installed as called for in Rule "g," the instrument cut-outs may be placed between the switchboard and the instrument, as near the switchboard as possible.

For all other Systems:—

1. Must be mounted on incombustible, non-absorptive, insulating bases, so designed that when the protector is in place, all parts which may be alive will be thoroughly insulated from the wall to which the protector is attached.

2. Must have the following parts:—

A lightning arrester, which will operate with a difference of potential between wires of not over 500 volts, and so arranged that the chance of accidental grounding is reduced to a minimum.

A fuse designed to open the circuit in case the wires become crossed with light or power circuits. The fuse must be able to open the circuit, without arcing or serious flashing, when crossed with any ordinary commercial light or power circuit.

A heat coil, if the sensitiveness of the instrument demand it, which will operate before a sneak current can damage the instrument which the protector is guarding.

Heat coils are necessary in all circuits normally closed through magnet windings, which cannot indefinitely carry a current of at least five amperes. They are intended to warm up and melt out with a current large enough to endanger the instrument if continued for a long time, but so small that it would not blow the fuses ordinarily found necessary for such instruments. The smaller currents are often called "sneak" currents.

3. The fuses must be so placed as to protect the arrester and heat coils, and the protector terminals must be plainly marked "line," "instrument," "ground."

An easily read abbreviation of the above words will be allowed.

The following rules apply to all systems whether the wires from the central office to the building are overhead or underground.

n. Wires beyond the protector, or wires inside buildings where no protector is used, must be neatly arranged and securely fastened in place in some convenient, workmanlike manner.

They must not come nearer than two inches to any electric light or power wire in the building, unless separated therefrom by some continuous and firmly fixed non-conductor creating a permanent separation; this non-conductor to be in addition to the regular insulation on the wire.

The wires would ordinarily be insulated, but the kind of insulation is not specified, as the protector is relied upon to stop all dangerous currents. Porcelain tubing or approved flexible tubing may be used for encasing wires where required as above.

o. 1. Wires, where bunched together in a vertical run within any building, must have a fire-resisting covering sufficient to prevent them from carrying fire from floor to floor, unless they are run either in incombustible tubing or in

a fire-proof shaft, which shaft must be provided with fire stops at each floor.

2. Signalling wires and electric light or power wires may be run in the same shaft, provided either that one of these classes of wires is run in incombustible tubing, or that when run otherwise the two classes of wires be separated from each other by at least two inches.

3. In no case must signalling wires be run in the same tube with electric light or power wires.

p. Transformers or other devices for supplying current to signalling systems from light, heat or power circuits must be of a design expressly approved for this purpose. The primary wiring must be installed in accordance with all such rules in Section "B" as are applicable.

VI. WIRELESS TELEGRAPH APPARATUS

Note:—These rules do not apply to Wireless Telegraph apparatus installed on shipboard.

In setting up Wireless Telegraph apparatus (so-called) all wiring within the building must conform to the rules in Section "B" for the class of work installed, and to the following additional requirements:—

a. Aerial conductors must be permanently and effectually grounded at all times when the station is not in operation.

The ground conductor, which must be of copper and not smaller than No. 4 B. and S. gauge, must run in as direct a line as possible, and must be connected to a water pipe at a point on the street side of all connections to the said water pipe within the premises, or to some other equally satisfactory earth connection.

b. Aerial conductors, when grounded as above specified, must be effectually cut off from all apparatus within the building.

c. As an alternative to the foregoing the aerial conductors may be permanently connected at all times to earth in the manner specified above, through a short-gap lightning arrester.

The arrester must have a gap of not over .015 inch between brass or copper plates not less than 2½ inches in length parallel to the gap and 1½ inches the other way, with a thickness of not less than one-eighth of an inch; it must be mounted upon incombustible, non-absorptive, insulating material of such dimensions as to give ample strength. Other approved arresters of equally low resistance and equally substantial construction may be used.

d. In cases where the aerial is grounded as specified in Rule "a," the switch employed to connect it to ground must not be smaller than a standard 100 ampere knife switch.

e. Where supply is obtained direct from a street service, the circuit must be installed in approved metal conduit, or armoured cable must be used.

f. In order to protect the supply system from high potential surges, there must be connected in circuit, either, a transformer having such a ratio that the potential on the secondary leads will not exceed 650 volts, or two condensers in series must be connected across the line.

The capacity of the condensers must not be less than one half micro-farad, and the connection between them must be permanently and effectually grounded.

VII. ELECTRIC RAILWAY WORK

1. Car Wiring and Equipment of Cars

a. PROTECTION OF CAR BODY, ETC.

1. The under side of the car bodies must be protected by approved fire-resisting, insulating material, not less than one-eighth inch in thickness, or by sheet iron or steel, not less than .04 inch in thickness, as specified in the following paragraphs, Nos. 2, 3 and 4.

This protection must be provided over all electrical apparatus, such as motors with a rating of over 75 h.p. each, resistances, contactors, lightning arresters, air-brake motors, etc., and also where wires are run, except that protection may be omitted over wires designed to carry 25 amperes or less if they are encased in metal conduit.

2. Over motors of more than 75 h.p. each, fire-resisting material, or sheet iron or steel, must extend not less than eight inches beyond all edges of openings in the motors, and not less than six inches beyond motor leads on all sides.

3. Over resistances, contactors and lightning arresters, and other electrical apparatus, excepting when amply protected by their casing, fire-resisting material, or sheet iron or steel, must extend not less than eight inches beyond all edges of the devices.

4. Over conductors not encased in conduit, and conductors in conduit when designed to carry over 25 amperes, unless the conduit is so supported as to give not less than one-half inch clear space between the conduit and the car, fire-resisting material, or sheet iron or steel, must extend at least six inches beyond conductors on either side.

The fire-resisting, insulating material, or sheet iron or steel, may be omitted over cables made up of flame-proof braided outer covering when surrounded by one-eighth inch flame-proof covering, as called for by Rule "i," paragraph 4.

5. In all cases fire-proof material or sheet iron or steel must have joints well fitted, be securely fastened to the sills, floor timbers and cross braces, and have the whole surface treated with a water-proof paint.

6. Cut-out and switch cabinets must be substantially made of metal.

b. WIRES, CABLES, ETC.

1. All conductors must be stranded, the allowable current-carrying capacity being determined by Table "A," "Conductors."

Exception may be made in the case of motor, trolley and resistance leads, which must in no case have a current-carrying capacity less than that of No. 7 B. and S. gauge copper wire, heater circuits not less than that of No. 12 B. and S. gauge copper wire, and lighting and other auxiliary circuits not less than that of No. 14 B. and S. gauge copper wire.

The current used in determining the size of motor, trolley and resistance leads shall be the per cent. of the full load current, based on one hour's run of the motor, as given by the following table:

Size of each Motor	Motor Leads	Trolley Leads	Resistance Leads
75 h.p. or less.....	50%	40%	15%
Over 75 h.p.....	45%	35%	15%

Fixture wire will be permitted for wiring approved clusters.

2. Must have an insulation and braid approved for use for the potential employed.

3. When run in metal conduit, must be protected by an additional braid.

Where conductors are laid in conduit, not being drawn through, the additional braid will not be required.

4. Must have an approved rubber covering (except that tape may be substituted for braid) and be protected by an additional flame-proof braid at least one thirty-second of an inch in thickness, and the outside must be saturated with a preservative flame-proof compound.

Observance of this rule is not necessary in the case of wires run in conduit or metal moulding, or made up into cables surrounded by one-eighth inch flame-proof covering.

The preservative flame-proof compound may be omitted from motor leads on motors so enclosed that flame cannot extend outside of the casing.

5. Must be so spliced or joined as to be both mechanically and electrically secure without solder. The joints must be soldered and covered with an insulation equivalent to that on the conductors.

Joints made with approved splicing devices and those connecting the leads at motors, plows or third-rail shoes need not be soldered.

6. All connections of cables to cut-outs, switches and fittings, except those to controller connection boards, when designed to carry over 25 amperes, must be provided with lugs or terminals soldered to the cable, and securely fastened to the device, by bolts, screws or by clamping; or, the end of the cable, after the insulation is removed, must be dipped in solder and be fastened into the device by at least two set screws having check nuts.

7. All connections for conductors to fittings, etc., designed to carry less than 25 amperes, must be provided with upturned lugs that will grip the conductor between the screw and the lug, the screws being provided with flat washers; or with block terminals having two set screws, and the ends of the conductors must be dipped in solder.

Soldering, in addition to the connection of the binding screws, is strongly recommended, and will be insisted on when the above requirements are not complied with.

This rule is only to apply to circuits where the maximum potential is over 25 volts and the current exceeds 5 amperes.

c. CUT-OUTS, CIRCUIT-BREAKERS, ETC.

1. All cut-outs and switches having exposed live metal parts must be located in metal cabinets. Cut-outs and switches, not in metal boxes or in cabinets, must be mounted on fire-resisting, insulating material, of not less than one-

fourth inch in thickness, which must project at least one-half inch beyond all sides of the cut-out or switch.

2. Cut-outs must be of the approved cartridge or approved blow-out type.

3. All switches controlling circuits of over 5 ampere rating must be of approved single-pole, quick-break or approved magnetic blow-out type.

Switches controlling circuits carrying 5 amperes or less may be of the approved single-pole, double-break, snap type.

4. A cut-out must be placed as near as possible to the current collector, so that the blowing of the fuse in this cut-out will cut off all current from the car.

When cars are operated by metallic return circuits, with circuit-breakers connected to both sides of the circuit, no fuses in addition to the circuit breakers will be required.

d. CONDUIT

When from the nature of the case, or on account of the size of the conductors, the ordinary pipe and junction box construction is not permissible, a special form of conduit system may be used, provided that the general requirements as given below are complied with.

1. Metal conduits and outlet and junction boxes must be constructed in accordance with standard requirements, except that the conduit for lighting circuits need not be over five-sixteenths inch internal diameter and one-half inch external diameter, and for heating and air motor circuits need not be over three-eighths inch internal diameter and nine-sixteenths inch external diameter, and all conduits where exposed to dampness must be water-tight.

2. Must be continuous between, and be firmly secured into, all outlet or junction boxes and fittings, making a thorough mechanical and electrical connection between same.

3. Metal conduits, where they enter all outlet or junction boxes and fittings, must be provided with approved bushings fitted so as to protect cables from abrasion.

4. Except as noted in Rule "i," paragraph 2, must have the metal of the conduit permanently and effectually grounded.

5. Junction and outlet boxes must be installed in such a manner as to be accessible.

6. All conduits, outlets or junction boxes and fittings must be firmly and substantially fastened to the frame-work of the car.

e. MOULDING

1. Only approved metal moulding may be used, except as specified in Rule "i," paragraph 2. (See Rules on "Moulding Work," Section "B.").

2. When constructed of fire-resisting, insulating material, as permitted in Rule "i," paragraph 2, the backing must not be less than one-fourth inch in thickness and be of a width sufficient to extend not less than one inch beyond the conductors at the sides.

The capping, which must not be less than one-eighth inch in thickness, must cover and extend at least three-fourths inch beyond conductors at either side.

The joints in the moulding shall be mitred to fit close, the whole material being firmly secured in place by screws or nails, and treated on the inside and outside wth a waterproof paint.

When fire-resisting moulding is used over surfaces already protected by one-eighth inch fire-resisting, insulating material no backing will be required.

f. LIGHTING AND LIGHTING CIRCUITS

1. Each outlet must be provided with an approved receptacle, or an approved cluster. No lamp consuming more than 128 watts must be used.

2. Circuits must be run in approved metal conduit, or approved metal moulding.

3. When metal conduit is used, except for sign lights, all outlets must be provided with approved outlet boxes.

4. At outlet boxes, except where approved clusters are used, receptacles must be fastened to the inside of the box, and the metal cover must have an insulating bushing around the opening for the lamp.

5. The exposed metal parts, of all electrical fittings and fixtures, which do not carry current, (except covers which are lined, such as those of sockets, snap switches, receptacles, etc.) must be permanently and effectually grounded.

g. HEATERS AND HEATING CIRCUITS

1. Panel heaters must be so constructed and located that when heaters are in place, all current-carrying parts will be at least four inches from all woodwork.

Heaters for cross seats must be so located that current-carrying parts will be at least six inches below the underside of the seats, unless the underside of the seat is protected by fire-resisting, insulating material of not less than one-fourth inch thickness, or by .04 inch sheet metal with one inch air space over it, when the distance may be reduced to three inches.

Truss plank heaters must be mounted on fire-resisting, insulating material of not less than one-fourth inch thickness, the legs or supports for the heaters providing an air space of not less than one-half inch between the back of the heater and the insulating material.

2. All circuits must be run in approved metal conduit or on porcelain knobs and cleats.

The latter method of wiring will only be allowed if the location of the conductors be such as to provide an air space of not less than two inches on all sides except the surface

wired over. The knobs and cleats must be mounted on fire-resisting, insulating material of not less than one-quarter inch thickness, extending at least three inches beyond the conductors on either side, the supports raising conductors not less than one-half inch from the surface wired over, and being not over twelve inches apart.

h. AIR-PUMP MOTOR AND CIRCUITS

1. Circuits must be run in approved metal conduit or in approved moulding.

If run below the floor of the car they may, as an alternative, be supported on porcelain knobs or cleats, provided that the supports raise the conductors at least one-half inch from the surface wired over and are not over twelve inches apart.

2. Automatic control must be enclosed in an approved metal box. The air-pump and motor, when enclosed, must be in an approved metal box or a wooden box lined with metal of not less than one-thirty-second inch in thickness.

When conductors are run in metal conduit, the boxes surrounding the automatic control and air pump and motor may serve as outlet boxes.

i. MAIN MOTOR CIRCUITS AND DEVICES.

1. Conductors connecting between trolley stand and main cut-outs or circuit-breakers in hood must be protected, where wires enter the car, to prevent ingress of moisture.

2. Conductors connecting between the third-rail shoes on the same truck must be supported in an approved fire-resisting, insulating moulding, or in approved iron conduit supported by soft rubber or other approved insulating cleats.

3. Conductors on the underside of the car, except as noted in paragraph 4, must be supported in accordance with one of the following methods:—

a. Must be run in approved metal conduit, junction boxes being provided where branches in conduit are made, and where conductors leave conduit the point of issue must be equipped with a suitable condulet or equivalent fitting.

b. Or must be run in approved fire-resisting, insulating moulding.

c. Or must be supported by insulating cleats, the supports being not over twelve inches apart.

4. a. Conductors, with flame-proof braided outer covering, connecting between controllers at either end of the car, or between controllers and contactors, may be run as a cable, provided that the cable, where exposed to the weather, is encased in a canvas hose or in canvas tape, which must be thoroughly taped or sewed at the ends, where taps from the cable are made, and also where the hose or tape enters the controllers.

b. Conductors, with or without flame-proof braided outer covering, connecting between controllers at either end of the car, or between controllers and contactors, may be run as a cable, provided that the cable, throughout its entire length, is surrounded by one-eighth inch flame-proof covering, thoroughly taped or sewed at ends or where taps from the cable are made, and that the flame-proof covering enters the controllers.

c. Cables, where run below the floor of a car, may be supported by approved insulating straps or cleats. Where run above the floor of the car, they must be in a metal conduit or metal channel, painted or galvanized both inside and out, and where this channel is so placed as to be exposed to water, as by washing of the car floor, it must either be water-proof or so arranged that water will readily drain out.

d. Canvas hose or tape or flame-proof material surrounding cables after conductors are in same, must have not less than two coats of water-proof insulating material.

5. Motors must be so drilled that, on double truck-cars, the connecting cables can leave them on the side nearest to the king bolt.

6. Resistances must be so located that there will be at least a six-inch air space between resistances proper and the fire-resisting material of the car.

They must be mounted on iron supports, being insulated therefrom by incombustible bushings or washers, the supports must have at least two inches of insulating surface between them and the metal work of the car; or the resistances may be mounted on hardwood bars, supported by iron stirrups, which bars must have not less than two inches of insulating surface between the foot of the resistance and the metal stirrup, the entire surface of the bars being covered with at least one-eighth inch fire-resisting, insulating material.

b. The insulation of the conductor, for about six inches from the terminal of the resistance, must be replaced, if any insulation be necessary, by a porcelain bushing or asbestos sleeve.

7. Controllers must be raised above the platform of the car by a hardwood block not less than one inch in thickness, the block being fitted and painted to prevent moisture from working in between it and the platform.

j. LIGHTNING ARRESTERS

1. Must preferably be so located as to protect all auxiliary circuits in addition to main motor circuits.

2. The ground conductor must have a current-carrying capacity not less than that of No. 6 B. and S. gauge copper wire, and be run with as few kinks and bends as possible, and must be securely grounded.

k. GENERAL RULES

1. When passing through floors, conductors or cables must be protected by approved incombustible, non-absorptive, insulating bushings, which must fit the conductor or cable as closely as possible.

2. Metal moulding must never be concealed (except where readily accessible), and must not be exposed to moisture.

3. Short bends in conductors must be avoided where possible.

4. Sharp edges in conduit or in moulding must be smoothed to prevent injury to conductors.

2. Car Houses

a. The trolley wires must be securely supported on insulating hangers.

b. The trolley hangers must be placed at such a distance apart that, in case of a break in the trolley wire, contact with the floor cannot be made.

c. Must have an emergency cut-out switch located at a proper place outside of the building, so that all the trolley wires in the building may be cut out at one point, and line insulators must be installed, so that when this emergency switch is open the trolley wire will be dead at all points within one hundred feet of the building. The current must be cut off from the building when not needed for use in the building.

This may be done by the emergency switch, or, if preferred, a second switch may be used which will cut off all current from the building, but which need not cut off the trolley wire outside, as would be the case with the emergency switch.

d. All lamps and stationary motors must be installed in such a way that one main switch will control the whole of each installation, lighting and power, independently of the main cut-out switch called for in Rule "c."

e. Where current for lighting and stationary motors is taken from a grounded trolley circuit, the following special rules must apply:—

1. Cut-outs must be placed between the non-grounded side and the lights or motors which they are to protect. No set or group of incandescent lamps requiring over 2,000 watts must be dependent upon one cut-out.

2. Switches must be placed between the non-grounded side and the lights or motors which they are to protect.

3. All rails must be bonded at each joint by a conductor having a current-carrying capacity at least equivalent to that of a No. 0, B. and S. gauge annealed copper wire, and all rails must be connected to the outside ground return circuit by a copper wire of not less than No. 0, B. and S. gauge, or by equivalent bonding through the track. All lighting, and stationary motor circuits, must be thoroughly and permanently connected to the rails, or to the wire leading to the outside ground return circuits.

f. All pendant cords and portable conductors will be considered as subject to hard usage.

g. Except as provided in Rule "e," all wiring and apparatus must be installed in accordance with the rules in Section "B."

h. Must not have any system of feeder distribution centring in the building.

i. Cars must not be left with the trolley in electrical connection with the trolley wire.

SECTION D

TESTING

Wiring in any building must test free from grounds, i.e., the complete installation must have an insulation resistance between conductors and between all conductors and the ground (not including attachments, socket receptacles, etc.), not less than that given in the following table:—

Up to	5 amperes	4,000,000	ohms
"	10 amperes	2,000,000	"
"	25 amperes	800,000	"
"	50 amperes	400,000	"
"	100 amperes	200,000	"
"	200 amperes	100,000	"
"	400 amperes	50,000	"
"	800 amperes	25,000	"
"	1,600 amperes	12,500	"

The test must be made with all cut-outs and safety devices in place. If the lamp sockets, receptacles, fixtures, etc., are also connected, only one-half of the resistances specified in the table will be required.

While it is possible, under favorable conditions, to obtain the foregoing insulation resistances, it has been found that it is in many cases difficult to do so, particularly in a new building in which there is a certain amount of moisture present. Where favorable conditions do not obtain, and where it is otherwise clearly evident that the work is satisfactory, rigid compliance with the rule will not be asked for, and the Commission may modify the requirements of the rule to an extent commensurate with the conditions.

SECTION E

GROUNDING

GROUNDING OF LOW-POTENTIAL CIRCUITS

The grounding of low-potential circuits under the following regulations is only allowed when such circuits are so arranged that, under normal conditions of service, there will be no passage of current along the ground wire.

1. Direct-Current 3-Wire Systems

a. The neutral wire must be grounded, and the following rules must be complied with:—

1. The ground connection must include all available water and gas pipe systems, and must be made at the central station.

2. In underground systems the neutral wire must also be grounded at each distributing box, through the box.

3. In overhead systems the neutral wire must be grounded at least every 500 feet in the manner set forth in Rules "c" to "g" below.

4. The ground wire in direct-current three-wire systems must not, at central stations, be smaller than the neutral wire and not smaller than No. 6 B. and S. gauge elsewhere.

2. Alternating Current Secondary Systems

b. Transformer secondaries of distributing systems (except where supplied from private industrial power or lighting plants where the primary voltage does not exceed 650 volts)* must be grounded provided the maximum difference of potential between the grounded point and any other point in the circuit does not exceed 150 volts, and may be grounded when the maximum difference of potential between the grounded point and any other point in the circuit exceeds 150 volts. In either case the following rules must be complied with:—

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*The interpretation of this clause as to the meaning of private industrial or lighting plant to be decided by the Commission in all cases.

1. The ground connection must be made at the neutral point or wire, whenever the neutral point or wire is accessible.

2. When no neutral point or wire is accessible, one side of the secondary circuit must be grounded.

3. Ground connections must be at the transformers and may also be made at individual services, if desired; when transformers feed systems having a neutral wire, the neutral wire must also be grounded at least every 500 feet.

c. When the ground connection is inside of any building or the ground wire is inside of, or attached to, any building (except central or sub-stations) the ground wire must be of copper and have an approved rubber insulating covering as required for potentials from 10 to 650 volts.

d. The ground wire must never be less than No. 6 B. and S. gauge, and on any three-phase system, must have a carrying capacity equal to that of any one of the three mains.

In connecting a ground wire to a piping system, the wire should be sweated into a lug attached to an approved clamp, the latter being firmly bolted to the pipe after all rust and scale have been removed; or the wire may be soldered into a brass plug and the plug forcibly screwed into a pipe fitting, or where the pipes are cast iron, into a hole tapped into the pipe itself. For large stations, where connecting to underground pipes having bell and spigot joints, it is well to connect to several lengths, as the pipe joints may be of rather high resistance.

Where ground plates are used, a No. 16 Stubb's gauge (No. 14 B. and S. gauge) copper plate, about 3 feet by 6 feet in size, with about 2 feet of crushed coke or charcoal about pea size, both under and over it, would make a ground of sufficient capacity for a moderate sized station, and would probably answer for the ordinary sub-station or bank of transformers. For a large central station, a plate with considerably more area might be necessary, depending upon the other underground connections available. The ground wire

should be rivetted to the plate in a number of places, and soldered for its whole length. Perhaps, even better than a copper plate, is a cast-iron plate with projecting forks, the idea of the fork being to distribute the connection to the ground over a fairly broad area, and to give a large surface contact. The ground wire can probably best be connected to such a cast iron plate by soldering it into brass plugs screwed into holes tapped in the plate. In all cases the joints between the plates and the ground wire should be thoroughly protected against corrosion by painting with waterproof paint or some equivalent.

e. The ground wire should, except for central stations and transformer sub-stations, be kept outside of the buildings as far as practicable, but may be directly attached to a building or pole by cleats or straps, or supported on porcelain knobs. Staples must never be used. The wire must be carried in as nearly a straight line as possible, avoiding kinks, coils and sharp bends, and must be protected where exposed to mechanical injury.

This protection must be secured by the use of approved conduit or its equivalent. The ground wire on the outside of a building, must be in conduit at all places where it is within seven feet from the ground, unless suitably protected in some equivalent manner.

f. The ground connections for central stations, transformer sub-stations and banks of transformers, must be permanent and effective and must include all available underground piping systems, including the lead sheath of underground cables.

g. For individual transformers and building services the ground connection may be made as in Rule "e," or may be made to water-piping systems running into buildings. This connection may be made by carrying the ground wire into the cellar and connecting it to the street side of all meters, main cocks, etc.

Where it is necessary to run a ground wire through any part of a building, unless run in approved conduit, it must be protected by porcelain bushings, through walls or partitions and generally treated in the same manner as "low potential" electric lighting wires.

h. Where the maximum difference of potential between the grounded point and any other point of the circuit exceeds 150 volts, grounding may be required, but such grounding must not be made without special permission. (See exception in Rule "b.")

3. Grounding of Conduit, Etc.

Ground wires, except for lightning arresters, must be of copper, and must have a sectional area in accordance with the following table:—

	Size of Ground Wire required B. and S. gauge
For grounding all interior conduits, service pipes, and metal moulding, and where the largest wire in circuit is not larger than No. 0, B. and S. gauge	No. 10
Where the largest wire is greater than No. 0, B. and S. gauge	No. 4
For generator and motor frames, transformer cases and switchboard frames.	No. 6
For covers of small apparatus	No. 10

Ground connections for conduit must not be used as a ground connection for any electric circuit; the connections for the two must be kept entirely separate though the same *ground* may be used.

SECTION F

MAINTENANCE AND OPERATION

a. All electrical installations must be kept in proper working condition and repair.

To ensure safety of operation, it is necessary to maintain all parts in good condition, to replace or properly repair broken insulators, covers, guards, lost parts, etc., and to maintain good contact on all switches, fuses, etc., and generally to keep every portion of an installation thoroughly effective for the purpose for which it is intended. Special attention is here drawn to ground connections. These must, wherever employed, be considered as an essential part of an installation, and the foregoing remarks, therefore, apply with equal force.

Alterations or extensions to existing installations must comply in all details with the rules laid down in the foregoing sections.

b. Adequate precautions must be taken to prevent any apparatus, conductor, etc., from being accidentally or inadvertently electrically charged when any person is working thereon.

The precautions adopted must be adequate, i.e., in some cases it will be sufficient to take out the switch and hang a notice on it to warn others not to touch it; in other instances it will be necessary to either station a man near the switch to see that no one touches it, to put a lock on the switch, or to take other equally effective measures.

c. Repairs or alterations must not be carried out on any live circuits unless the conditions do not permit an interruption of the circuit.

In some instances, for example where apparatus on a distribution board needs attention, it may be impracticable to make the whole board dead, or it may be necessary to work upon an oil switch, the terminals on the generator side of which cannot be conveniently made dead; exceptions may be made in these and similar instances. In premises containing explosive materials, repairs or alterations must never be carried out on any live circuit.

d. Where necessary, insulating stands, mats, tongs, spanners, boots, gloves, etc., must be provided and must be maintained in good condition.

Local conditions will, to some extent, decide under what circumstances such appliances are necessary, e.g., with installations supplied at pressures up to 300 volts, the danger from shock is small, but at higher potentials and especially where there is danger of shock by standing upon a damp floor, or touching other conducting material, rubber mats, rubber gloves and other appliances will be essential.

e. Inflammable material must be kept at a distance of at least one foot from any apparatus or fittings, except in cases where these are provided with covers or other effective protection.

For example, silks, lace curtains, etc., must not be placed near to incandescent lights; and oil, gasoline, excelsior and shavings, etc., must not be placed near any motor, lamps or apparatus in which heat is generated or in which sparking is liable to occur.

f. Passageways around switchboards, motors, or apparatus must be kept clear of any obstruction.

The passageways around switchboards, etc., not normally being used for other purposes, are frequently looked upon as convenient places in which to store waste, cans of oil, packing cases, etc. This is a dangerous practice, not only from the point of view of fire, but also because such articles seriously interfere with the operation of, or any repairs or alterations to, the switchboard, etc.

g. All those parts of premises containing electrical apparatus requiring attention while in operation, must be adequately lighted.

Efficient lighting is essential, if electrical apparatus has to be attended to while it is alive.

The switches for the lights called for in this rule must be outside the danger zone, e.g., lights may be needed in the pit of a large motor, but the switches must be situated at some point outside the pit.

h. A competent man must be kept on duty where generators are operating.

i. Where potentials exceeding 650 volts are employed, a notice of a permanent character must be placed where it will be observed by those concerned, forbidding anyone to work on any apparatus or conductors without either having them made dead, or, if this be not possible, without using rubber gloves, insulated spanners, rubber mats, etc., and taking all such precautions as may, under the circumstances, be necessary to prevent danger.

The use of rickety boxes, stools, unserviceable ladders, etc., must be strictly forbidden.

The appliances referred to by the rule must be kept always in the same place, which must be convenient and central, so that those concerned will know where to find them.

j. In all premises in which electrical energy of a higher potential than 300 volts is used, instructions as to treatment of persons suffering from electric shocks must be fixed in plain view in some prominent situation.

Instructions for Resuscitation will be found at the end of this book.

SECTION G

DEFINITIONS

In these Regulations, the following terms shall be interpreted in the sense herein defined. Other words or terms used, which are not specifically defined shall be interpreted in their usually accepted sense.

"Accessible" means not only that any equipment, apparatus, etc., to which the term is applied, shall be within easy reach, but that it must also be safe for anyone to get at.

For example, a switch may be placed in a position within reach, but in order to operate it, one may have to stoop under a running belt, or reach over a machine, etc.—such a position will not be considered as "accessible" or "easy of access."

"Inaccessible" or "remote from access" means that any equipment or apparatus, etc., to which the term is applied, shall be so placed that unauthorized persons cannot, except deliberately, touch or tamper with it.

"Concealed," in reference to wiring, means wiring on insulators or knobs and tubes installed in partition walls or between floors and ceilings, etc., in such a manner that it cannot be inspected after it is covered in. The word is not intended to refer to mere concealment from view by means which would allow of inspection being made when required.

"Insulator" or "Insulation," means such insulator or insulation as may be adequate to effectually obtain the desired end in any particular case.

"Combustible" means that the materials to which the term is applied will ignite, and burn or smoulder.

"Fire-proof" means incapable of being ignited, or even of smouldering.

"Inflammable material" means any material which will readily burst into flame, e.g., wood shavings, oils, light draperies, celluloid, etc.

"Damp places" are any premises, room or portion thereof, in which the presence of moisture, either permanently or intermittently, is such as would injuriously affect the insulation of an installation suitable for ordinary conditions, and would greatly increase the risk of shock and fire, owing to the reduced insulation resistance to ground and between conductors.

"Premises containing corrosive liquids or vapors" means any premises, room or portion thereof, in which an installation would be subjected to injurious chemical action due to the presence of such liquids or vapors.

"Premises containing explosive materials" means any premises, room or portion thereof, in which explosive materials, in solid, liquid, pulverized or gaseous form are exposed in such a way as to constitute risk of fire or explosion.

The term "Theatre" shall mean a building, or that part of a building, regularly or frequently used for dramatic, operatic, moving picture or other performances or shows, or which has a stage for such performances used with scenery or other stage appliances.

"Supply Authority."—By this term is meant any person, company or corporation, municipal or otherwise, supplying electrical energy for other than his or their own use.

"Switchboards."—By this term is meant a collection of switches and other controlling, regulating and indicating devices, assembled together on one or more panels, all mounted on a suitable frame, and used for the control and regulation of the main sources of electrical supply. They are to be distinguished from "panels" on which are grouped fuses and switches used for the control of branch circuits throughout a building, and which are placed at the various

branch distribution centres, or used for the control of individual apparatus such as motors, vapor lamps, rectifiers, etc.

"Maker's name" means, either the name of the actual manufacturer, or that of a responsible jobber or other distributor who has duly notified the Commission, in writing, of his intention of selling certain specified articles under his own name.

"Permission" or "Special permission" means the express permission, in writing, of the Commission, to do, or to refrain from doing, something which is contrary to the rule in connection with which the term is used.

By the word "Commission" is meant the Hydro-Electric Power Commission of Ontario.

INSTRUCTIONS ON RESUSCITATION FROM ELECTRIC SHOCK*

TREATMENT FOR ELECTRIC SHOCK

An accidental electric shock usually does not kill at once, but may only stun the victim and for a while stop his breathing.

The shock is not likely to be immediately fatal, because:—

a. The conductors may make only a brief and imperfect contact with the body.

b. The skin, unless it is wet, offers high resistance to the current.

Hope of restoring the victim lies in prompt and continued use of artificial respiration. The reasons for this statement are:—

a. The body continuously depends on an exchange of air, as shown by the fact that we must breathe in and out about fifteen times a minute.

b. If the body be not thus repeatedly supplied with air, suffocation occurs.

c. Persons whose breathing has been stopped by electric shock have been reported restored after artificial respiration has been continued for approximately two hours.

The Schäfer, or "prone pressure," method of artificial respiration, slightly modified, is illustrated and described in the following resuscitation rules. The advantages of this method are.—

a. Easy performance; little muscular exertion is required.

b. Larger ventilation of the lungs than by the supine method.

*N. E. L. A.

c. Simplicity; the operator makes no complex motions, and readily learns the method on first trial.

d. No trouble from the tongue falling back into the air passage.

e. No risk of injury to liver or ribs, if the method be executed with proper care.

Aid can be rendered best by one who has studied the rules and has learned them by practice on a volunteer subject.

INSTRUCTIONS FOR RESUSCITATION

FOLLOW THESE INSTRUCTIONS EVEN IF THE VICTIM APPEAR DEAD

I. Break the Circuit Immediately

1. With a single, quick motion, separate the victim from the live conductor. In doing so, avoid receiving a shock yourself. Many have, by their carelessness, received injury in trying to disconnect victims of shock from live conductors.

OBSERVE THE FOLLOWING PRECAUTIONS

a. Use a dry coat, a dry rope, a dry stick or board, or any other *dry non-conductor* to move either the victim or the wire, so as to break the electrical contact. Beware of using metal or any moist material. The victim's loose clothing, if dry, may be used to pull him away; do not touch the soles or heels of his shoes while he remains in contact—the nails are dangerous.

b. If the body must be touched by your hands, be sure to cover them with rubber gloves, mackintosh, rubber sheeting or dry cloth; or stand on a dry board or some other dry, insulating surface. If possible, use only one hand.

If the victim is conducting the current to the ground, and is convulsively clutching the live conductor, it may be easier to shut off the current by lifting him than by leaving him on the ground and trying to break his grasp.

2. Open the nearest switch, if that be the quickest way to break the circuit.

3. If necessary to cut a live wire, use an ax or a hatchet with a dry, wooden handle, or properly insulated pliers.

II. Send for the Nearest Doctor

This should be done without a moment's delay, as soon as the accident occurs, and while the victim is being removed from the conductor.

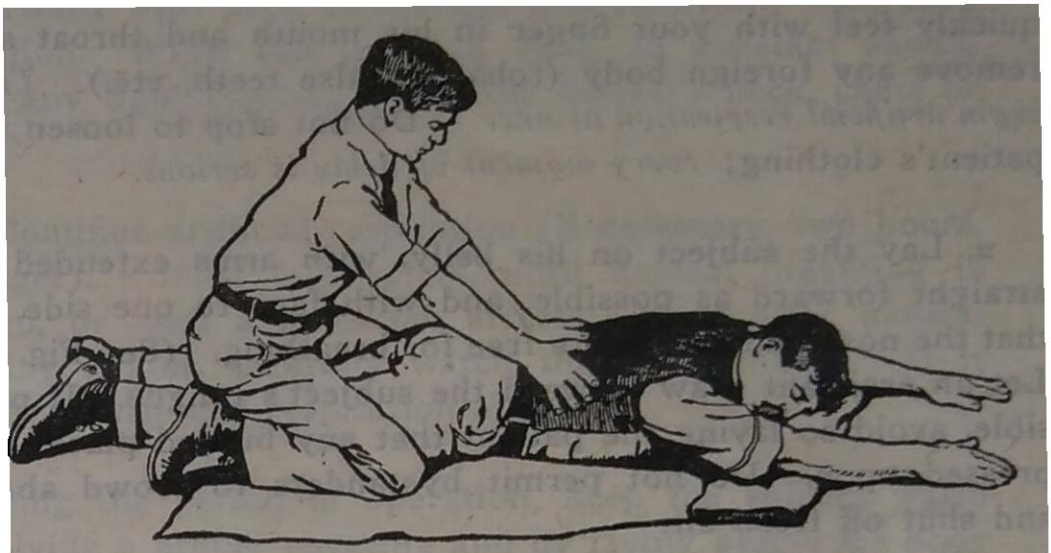

Fig. 1—Inspiration : Pressure Off

Fig. 2—Expiration : Pressure On

III. Attend Instantly to Victim's Breathing

1. As soon as the victim is clear of the live conductor, quickly feel with your finger in his mouth and throat and remove any foreign body (tobacco, false teeth, etc.). *Then begin artificial respiration at once.* Do not stop to loosen the patient's clothing; *every moment of delay is serious.*

2. Lay the subject on his belly, with arms extended as straight forward as possible, and with face to one side, so that the nose and mouth are free for breathing. (See Fig. 1.) Let an assistant draw forward the subject's tongue. If possible, avoid so laying the patient that any burned places are pressed upon. Do not permit bystanders to crowd about and shut off fresh air.

3. Kneel straddling the subject's thighs and facing his head; rest the palms of your hands on the loins (on the muscles of the small of the back), with the thumbs nearly touching each other, and with the fingers spread over the lowest ribs. (See Fig. 1.)

4. With arms held straight, swing forward slowly, so that the weight of your body is gradually brought to bear upon the subject. (See Fig. 2.) This operation, which should take from two to three seconds, must not be violent—internal organs may be injured. The lower part of the chest and also the abdomen are thus compressed, and air is forced out of the lungs.

5. Now, *immediately* swing backward so as to remove the pressure, but leave your hands in place, thus returning to the position shown in Fig. 1. Through their elasticity, the chest walls expand and the lungs are thus supplied with fresh air.

6. After two seconds, swing forward again. Thus repeat deliberately, twelve to fifteen times a minute, the double movement of compression and release—a complete respira-

tion in four or five seconds. If a watch or clock is not visible, follow the natural rate of your own deep breathing—swinging forward with each expiration, and backward with each inspiration. While this is being done, an assistant should loosen any tight clothing about the subject's neck, chest or waist.

7. Continue artificial respiration (if necessary, two hours, or longer), *without interruption,* until natural breathing is restored, or until a physician arrives. Even after natural breathing begins, carefully watch that it continues. If it stops, start artificial respiration again.

During the period of operation, keep the subject warm by applying a proper covering and by laying beside his body bottles or rubber bags filled with warm (not hot) water. The attention to keeping the subject warm should be given by an assistant or assistants.

8. *Do not give any liquids whatever by mouth until the subject is fully conscious.*

FIRST CARE OF BURNS

When natural respiration has been restored, burns, if serious, should be attended to until a doctor comes.

A raw or blistered surface should be protected from the air. If clothing sticks, do not peel it off—cut around it. The adherent cloth, or a dressing of cotton or other soft material applied to the burned surface, should be saturated with picric acid (0.5 per cent.). If this is not at hand, use a solution of baking soda (one teaspoonful to a pint of water), or the wound may be coated with a paste of flour and water; or it may be protected with a heavy oil, such as machine oil, transformer oil, vaseline, linseed, carron, or olive oil. Cover the dressing with cotton, gauze, lint, clean waste, clean handkerchiefs, or other soft cloth, held lightly in place by a bandage.

The same covering should be lightly bandaged over a dry, charred burn, but without wetting the burned region or applying oil to it. Do not open blisters.

USEFUL DATA

a. To ascertain the full load amperes per terminal of alternating-current and direct-current motors.

1. Single phase. Full load amperes per terminal

$$\frac{\text{Rated h.p. of motor} \times 746 \times 100 \times 100.}{\text{Voltage} \times \text{Power Factor per cent.} \times \text{Efficiency per cent.}}$$

2. For two-phase motors work out the same calculation and divide by two.

3. For three-phase motors work out the same calculation and divide by 1.732.

Example:—A 3-phase 25-cycle 550-volt motor of 25 h.p. rating has at full load a power factor of 90% and an efficiency of 88%; then—

$$\frac{25 \times 746 \times 100 \times 100}{550 \times 90 \times 88 \times 1.732}$$

=practically 25 amperes per terminal at full load.

If the power factor and efficiency be stated in the form "0.9 x 0.88" then leave out the 100 x 100 from the numerator of the calculation, this in the example given will then become:—

$$\frac{25 \times 746}{550 \times 0.9 \times 0.88 \times 1.732}$$

For direct-current motors the full load amperes=

$$\frac{\text{Rated h.p. of motor } 746 \times 100}{\text{Voltage} \times \text{Efficiency per cent.}}$$

b. The size of wire for motors must be chosen with reference to local conditions. In the first place "Rule b," "Motors," page 14, must be observed, and in any long runs regard must be had to the voltage drop, which should not [illegible] 5%.

TABLE A

WIRING TABLE FOR TWO PER CENT. LOSS ON 110 VOLTS

APPROXIMATE DISTANCE IN FEET TO CENTRE OF DISTRIBUTION.
WIRE SIZES IN B. & S. GAUGE. CALCULATED FOR 60 DEG. FAHR.

No. of Amps	FEET																					Remarks
	20	30	40	50	60	70	80	90	100	120	140	160	180	200	240	280	320	360	400	450	500	
1.0	....	....	....	....	....	....	....	....	....	....	....	18	....	....	....	16	....	....	....	14	....	
1.5	....	....	....	....	....	....	....	....	....	18	....	....	16	....	....	14	....	....	....	12	....	
2.0	....	....	....	....	....	....	....	18	....	....	16	....	....	14	....	....	....	12	....	....	....	
3.0	....	....	....	....	18	....	....	16	....	....	14	....	....	....	12	....	....	10	....	....	....	
4.0	....	....	**18**	....	....	16	....	....	14	....	....	12	....	....	....	10	....	....	....	8	....	Figures in black face type are only applicable to wires with other than rubber insulation. See page 40, Table "B."
5.0	....	**18**	....	16	....	....	....	14	....	....	12	....	....	10	....	....	....	8	....	....	....	
6.0	....	....	16	....	....	14	....	....	12	....	....	....	10	....	....	8	....	....	....	6	....	
7.0	....	....	**16**	....	14	....	....	....	12	....	....	10	....	....	8	....	....	....	6	....	....	
8.0	....	**16**	....	14	....	....	....	12	....	....	10	....	....	8	....	....	....	6	....	5	....	
9.0	....	**16**	....	14	....	....	12	....	....	10	....	....	....	8	....	....	6	....	5	....	4	
10.0	**16**	....	14	....	....	12	....	....	10	....	....	....	8	....	....	6	....	5	....	4	....	
12.0	....	14	....	....	12	....	....	10	....	....	8	....	....	....	6	5	....	4	....	3	....	For 220 volts multiply the distance in feet by two, for the same percentage drop.
14.0	....	14	....	12	....	....	10	....	....	8	....	....	....	6	5	....	4	....	3	....	....	
16.0	14	....	12	....	....	10	....	....	8	....	....	6	....	5	....	4	....	3	....	2	....	
18.0	14	....	12	....	10	....	....	....	8	....	6	....	....	5	4	....	3	....	2	....	1	
20.0	14	12	....	10	....	....	....	8	....	....	6	....	5	4	....	3	....	2	....	1	....	
25.0	....	12	10	....	....	8	....	....	6	....	5	....	4	3	....	2	....	1	....	1/0	....	
30.0	....	10	....	....	8	....	....	6	....	5	4	....	3	....	2	1	....	1/0	....	2/0	....	
35.0	....	....	....	8	....	....	6	....	5	4	....	3	....	2	1	....	1/0	....	2/0	....	....	
40.0	....	....	8	....	....	6	....	5	4	....	3	....	2	1	....	1/0	....	2/0	....	3/0	....	
45.0	....	....	8	....	6	....	5	....	4	3	....	2	....	1	1/0	....	2/0	....	3/0	....	....	
50.0	....	8	....	6	....	5	....	4	3	....	2	....	1	1/0	....	2/0	....	3/0	....	4/0	....	
60.0	....	....	6	....	5	4	....	3	....	2	1	....	1/0	....	2/0	3/0	....	4/0	....	....	....	
70.0	....	....	6	5	4	....	3	....	2	1	....	1/0	....	2/0	3/0	....	4/0	....	....	....	....	
80.0	....	....	....	5/4	....	3	....	2	1	....	1/0	....	2/0	3/0	....	4/0	....	....	....	....	....	
90.0	....	....	....	4	3	....	2	....	1	1/0	....	2/0	....	3/0	4/0	....	....	....	....	....	....	
100.0	....	....	....	3	....	2	....	1	1/0	....	2/0	....	3/0	4/0	....	....	....	....	....	....	....	
125.0	....	....	....	2	....	1	....	1/0	2/0	....	3/0	....	4/0	....	....	....	....	....	....	....	....	
150.0	....	....	....	....	1	1/0	....	2/0	....	3/0	4/0	....	....	....	....	....	....	....	....	....	....	
175.0	....	....	....	....	1/0	....	2/0	....	3/0	4/0	....	....	....	....	....	....	....	....	....	....	....	
200.0	....	....	....	1/0	....	2/0	....	3/0	4/0	....	....	....	....	....	....	....	....	....	....	....	....	
250.0	....	....	....	....	....	3/0	....	4/0	....	....	....	....	....	....	....	....	....	....	....	....	....	
300.0	....	....	....	....	....	4/0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	

TABLE B
STANDARD STRANDING TABLE*

Size B. & S. Gauge	Diameter of Bare Cable in Inches	Number of Wire in Strand	Gauge of Individual Wire
16	.....	4	24 B. & S.
		3	25 B. & S.
14	.....	4	22 B. & S.
		3	23 B. & S.
12	.....	4	20 B. & S.
		3	21 B. & S.
10	.....	4	18 B. & S.
		3	19 B. & S.
8	.147	4	16 B. & S.
		3	17 B. & S.
6	.180	4	14 B. & S.
		3	15 B. & S.
5	.209	4	13 B. & S.
		3	14 B. & S.
4	.234	4	12 B. & S.
		3	13 B. & S.
3	.263	4	11 B. & S.
		3	12 B. & S.
2	.295	4	10 B. & S.
		3	11 B. & S.
1	.325	5	13 B. & S.
		14	14 B. & S.
0	.378	5	12 B. & S.
		14	13 B. & S.
00	.425	5	11 B. & S.
		14	12 B. & S.
000	.475	5	10 B. & S.
		14	11 B. & S.
0000	.524	5	9 B. & S.
		14	10 B. & S.
Circular Mils 250000	.568	1	8 B. & S.
		18	9 B. & S.

*Canadian General Electric Co., Ltd.

STANDARD STRANDING TABLE—Continued.

Size B. & S. Gauge	Diameter of Bare Cable in inches	Number of Wires in Strand	Gauge of Individual Wire
300000	.637	37	11 B. & S.
350000	.680	1	13 B. & S.
		33	10 B. & S.
400000	.735	31	10 B. & S.
		6	9 B. & S.
500000	.820	32	9 B. & S.
		5	8 B. & S.
600000	.900	15	11 B. & S.
		46	10 B. & S.
700000	.965	36	10 B. & S.
		25	9 B. & S.
750000	1.020	22	10 B. & S.
		39	9 B. & S.
800000	1.037	1	8 B. & S.
		60	9 B. & S.
900000	1.096	30	8 B. & S.
		31	9 B. & S.
1000000	1.157	61	8 B. & S.

TABLE C

RIGID METAL CONDUIT

This table does not take into consideration any question of long runs or awkward bends, but merely the greatest number of wires which conduit will take.

It should be noted that the Rules limit the number of circuits in any one conduit to four 2-wire or three 3-wire.

Standard Conduit Sizes, Inches	Normal Internal Diameter Inches	Actual Outside Diameter Inches	Greatest Number of Wires which Conduit will take																
			Solid wire single conductor, double braid									Stranded wire, single conductor, double braid							
			1	2	3	4	5	6	7	8	9	1	2	4	5	6	7	8	9
⅜	.62	.84	3	12	14	.....	.....	.....	.....	.....	.....	4	14	.....	.....	.....	.....	.....	.....
½	.82	1.05	00	8	10	12	.....	.....	.....	.....	.....	1	8	10	.....	.....	.....	.....	.....
¾	1.04	1.31	0000	3	6	8	10	12	.....	.....	.....	0000	3	8	10	12	14	.....	.....
1	1.38	1.66	.....	0	2	4	6	.....	8	.....	10	400000	1	4	6	.....	8	10	12
1¼	1.61	1.90	.....	.....	.....	2	4	6	.....	.....	8	600000	00	2	3	6	.....	.....	8
1½	2.06	2.37	.....	0000	000	00	1	2	3	.....	4	1000000	250000	00	1	2	3	.....	4
2	2.46	2.87	.....	.....	0000	000	00	0	1	.....	.....	1800000	350000	0000	00	1	.....	2	.....
2½	3.06	3.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	2000000	700000	400000	.....	.....	.....	.....	.....
3	3.54	4.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	800000	500000	.....	.....	.....	.....	.....
3½	4.02	4.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1200000	850000	.....	.....	.....	.....	.....
4	4.51	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1400000	1000000	.....	.....	.....	.....	.....
4½	5.04	5.56	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1700000	1300000	.....	.....	.....	.....	.....
5	6.06	6.62	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2000000	1700000	.....	.....	.....	.....	.....
6	7.02	7.62	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2000000	.....	.....	.....	.....	.....
7																			

RIGID METAL CONDUIT—Continued

Standard Conduit Sizes, Inches	Normal Internal Diameter Inches	Actual Outside Diameter Inches	Greatest Number of Wires which Conduit will take																
			Solid Twin Wire, Double Braid									Stranded Twin Wire, Double Braid							
			1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
½	.62	.84	10									10								
¾	.82	1.05	8	12								8	12							
1	1.04	1.31		6	10	14						6	8	12						
1¼	1.38	1.66				10		14					6	10	12		14			
1½	1.61	1.90			6	8		10	12		14			6	8		10	12		14
2	2.06	2.37						6	8								6	8		
2½	2.46	2.87								6								6		
3	3.06	3.50																		
3½	3.54	4.00																		
4	4.02	4.50																		
4½	4.51	5																		
5	5.04	5.56																		
6	6.06	6.62																		
7	7.02	6.76																		

Except for straight lengths of conduit free from bends between outlets not more than the following No. 14 B. & S. gauge wires shall be installed.

Conduit	Number of No. 14 B. & S. Gauge Wires
½ in.	3
¾ in.	6
1 in.	9

INDEX

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E. For Inspecting Residential Fixtures.

When fixtures can be inspected along with wiring, a charge of 25c. over and above wiring inspection fees will be made. When special fixture inspections are required or necessary a charge of one-half the wiring inspection fee will be made, rating each fixture as an outlet with the minimum fee of 25c.

F. For Special Inspections.

Where no special fee is provided, inspections may be made at the rate of 50c. per hour, plus any actual travelling and hotel expenses.

G. Permit Fees.

A fee of 10c. is to be paid by the applicant for each and every permit.

Reginald
Holt Howard
Reginald
Reg
Reginald
Reg Roy
Rea
Hay